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CORRELATION OF THE DSR WITH THE STRENGTH OF GLASS OF DIFFERENT COMPOSITIONS AND CONFIGURATIONS

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Project No. 7381, Task No. 738102

(Prepared under Contract No. AF 33(657)-11219 by the Pittsburgh Plate Glass Company, Glass Research Center, Harmar Township, Pennsylvania; R. W. Ansevin, author)

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GLASS DIVISION RESEARCH LABORATORIES

CORRELATION OF THE DSR WITH THE STRENGTH OF GLASS OF DIFFERENT COMPOSITIONS AND CONFIGURATIONS

FINAL TECHNICAL REPORT

GOVERNMENT CONTRACT NO. AF 33(657)-11219

PROJECT NO. 7381, TASK NO. 738102

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FOREWORD

This report was prepared by the Pittsburgh Plate Glass Company, Glass Research Center, under USAF Contract No. AF 33(657)-11219. The contract was initiated under Project No. 7381, Task No. 738102. The work was administrated under the direction of the Air Force Materials Laboratory, Research Technology Division, Mr. E. W. McKelvey, Project Officer.

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ABSTRACT

The Differential Surface Refractometer (DSR) is an instrument recently developed at the Glass Research Division of the Pittsburgh Plate Glass Company to detect and estimate the stress in the surface layers of glass by nondestructive means. This work shows a correlation between the instrument readings and experimental break strength data for glass of different compositions and configurations. In addition, the utility and some of the limitations of the instrument are discussed.

This report has been reviewed and is approved.

W. P. Conrardy

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INTRODUCTION

Numerous attempts have been made in the past to determine the strength of tempered glass by nondestructive examination of the finished product. The results of these attempts, however, were not accurate enough to be of practical value and, in general, the strength of glass had to be found by the destructive testing of a large number of samples. With the development of the Differential Surface Refractometer, we believe the nondestructive evaluation of the strength of tempered glass is now possible.

The breakage of glass takes place under tension, and in general, the degree of tension required to cause failure is controlled by the presence of surface flaws. The surface condition has a considerable influence on the strength of glass; the stability of glass is dependent upon the magnitude and distribution of these surface flaws so that under ordinary conditions, the strength of a piece of glass is determined by the strength of its surface. The dependence of strength on the distribution of flaws explains the large variations obtained in any determination of the modulus of rupture. Due to this variation, the strength of glass is a property which has a meaning only in a statistical sense. Hence, in this sense, the strength of annealed glass of a given production process can be expressed in terms of a critical or basic tensile stress. The tempering of glass causes the surface to be placed in a state of compression which has to be overcome before the glass surface can be subjected to a tensile stress of sufficient magnitude to cause failure. As a result, the strength of glass is increased by the presence of compressive stresses on the surface. This strength or modulus of rupture of tempered glass may be assessed as the sum of the basic strength, i.e., the stress required to cause failure in the absence of compressive forces on the surface, plus the compressive stress induced by the tempering process. Therefore, with a knowledge of the basic strength, the ability to measure the degree of surface compression present on glass by nondestructive means would provide a method of determining glass strength.

Among the optical methods investigated over the past decade for the nondestructive evaluation of the strength of tempered glass, surface refractometry was found to be particularly well suited for the quantitative measurement of the surface compression of tempered glass. The Differential Surface Refractometer (DSR), an instrument based on the principles of surface refractometry[1], was recently developed at the Pittsburgh Plate Glass Company, Glass Research Center, expressly for this purpose. After suitable calibration, the DSR is capable of measuring the degree of surface compression present on tempered glass directly in pounds per square inch.

The primary intent of this report is to show a correlation between the DSR and the strength of glass of various compositions and configurations through the use of experimental break strength data obtained in the laboratory. Specifically, the following table lists the types and thicknesses of glass that were investigated:

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TABLE 1
GLASS TYPES INVESTIGATED

Thickness in Inches	Degree of Temper: None (Annealed)	1/2	3/4	Full
1/10 to 3/16	E	-	-	D and E
3/16	A	A	A	A
1/4	A and B	A and B	A and B	A and B
1/2	A and B	A and B	A and B	A and B
3/4	A	-	-	A

Legend: Type of Glass

A - Type I MIL-G-25667, polished plate glass obtained from Pittsburgh Plate Glass Company.

B - Alumino Silicate, high strain point glass No. 6695 obtained from Pittsburgh Plate Glass Company.

D - Chemcor, code 0311 glass obtained from Corning Glass Company.

E - Herculite II, No. 7265 glass obtained from Pittsburgh Plate Glass Company.

In addition, the utility and some of the limitations of the DSR were determined.

CORRELATION REQUIREMENTS

In order to correlate the readings of the DSR with the strength of tempered glass it is necessary to determine the following information for each glass type listed in Table 1:

(1) The DSR calibration value for the glass.

(2) The basic strength of the glass, i.e., the strength of the glass in the annealed state.

(3) The degree of surface compression present on the tempered glass by means of the DSR readings.

(4) The breaking strength, or modulus of rupture, of the tempered glass.

From this data we would want to show the following equation to be valid within the limits of experimental accuracy:

$$\left\{\begin{matrix}\text{Basic}\\ \text{Strength}\end{matrix}\right\} + \left\{\begin{matrix}\text{DSR Reading of}\\ \text{Surface Compression}\end{matrix}\right\} = \left\{\begin{matrix}\text{Modulus of}\\ \text{Rupture}\end{matrix}\right\}$$

Of course, the three components of this equation are to be interpreted statistically and each component would represent the mean result obtained in the examination of a number of samples.

PROCEDURE

Adaptation of the DSR to Other Glass Types

Since the DSR was originally designed to operate specifically on plate and sheet glass of a given index range, some slight changes were required in the basic design of the instrument to extend its use to the other glass types investigated in this work. This was necessitated by the different indices and/or the magnitudes of stress which are characteristic of the other glass types. As a result, three different instruments were used in this study. The basic design, the DSR, was used on Type I MIL-G-25667 glass (polished plate); the Modified Differential Surface Refractometer-I, or MDSR-I, was used for the measurement of surface compression on both Chemcor and Herculite II; and, the MDSR-II was used for the examination of the Alumino Silicate glass.

Calibration

The DSR, suitably modified for each glass type when required, was calibrated by subjecting fully tempered samples to mechanical beam loading. Loading was applied in suitable increments; at each load increment, a corresponding reading of the DSR instrument was made. The DSR reading was compared with the induced stress calculated from beam bending theory. From this data, the surface compression of the sample at zero load was estimated using the method of least squares. Dividing the value obtained for the surface compression at zero load by the DSR reading for the same condition gives the instrument's calibration value, K, in psi per micrometer eyepiece unit, for each sample.

In addition, the stress-optic constant for each glass type was determined by measuring the difference between the surface refractive indices, $n_{\parallel}$ and $n_{\perp}$, for light polarized parallel and perpendicular to the surface of the stressed sample, respectively. The stress-optic constant C, in psi per unit birefringence, is given by

$$C = \sigma / n_{\parallel} - n_{\perp}$$

where σ is the surface laminar stress.

The difference $n_{\parallel} - n_{\perp}$ used to calculate the stress-optic constant is measured directly with the DSR. This direct measurement of $n_{\parallel} - n_{\perp}$ is more accurate, to at least an order of magnitude, than the measurement of $n_{\parallel}$ and $n_{\perp}$ separately and then forming the difference. The separate surface indices were also measured, however, to give an indication of their relative values. These results are summarized below in Table 2.

TABLE 2
SUMMARIZED MEAN CALIBRATION RESULTS

Glass Type	Surface Stress Instrument	Calibration Value, K, psi/Eyepiece Unit	Standard Deviation	Stress-Optic Constant**, C, psi/Unit Birefringence	Surface Indices $n_{\parallel}$	$n_{\perp}$
Type I MIL-G-25667	DSR	60.18*	0.41	5.4×10^7	1.5246	1.5250
Chemcor	MDSR-I	173.4 *	13.	4.4×10^7	1.5121	1.5130
Alumino Silicate	MDSR-II	167.2 *	2.5	5.8×10^7	1.5576	1.5580
Herculite II	MDSR-I	189.3 *	11.	5.0×10^7	1.5142	1.5153

*The relative differences in the magnitudes of the calibration values listed here are, to a great extent, accounted for by a difference of telescope power between the DSR and its modified forms.

**The stress-optic constants listed here represent values obtained by examining the surface layers of each type glass. These values may be different from those obtained by examining the bulk material. This would be especially true for Chemcor and Herculite II.

The methods used in determining the surface refractive indices and their differences, and the details of the calibration procedure are contained in Appendix I. Detailed results are listed in Table 6 of Appendix I.

Sample Preparation

All specimens, with the exception of Chemcor, were made from regular production glass from the Pittsburgh Plate Glass Company. The cutting was handled by normal plant methods with an added stipulation that all cutting be made from the same surface. These samples were tempered at the Glass Research Center in accordance with Table 1. No edge work was performed on these samples. The Chemcor samples were obtained fully tempered from the Corning Glass Company. These samples were received with the edges ground to a rounded contour.

In general, 25 specimens were prepared for each category listed in Table 1. Approximately twice this amount, however, were prepared for the testing of the Chemcor and Herculite II glass types.

The glass surfaces were carefully protected against mechanical damage during preparation of the specimens and during measurements. Paper was placed between each sample and its neighbor in order to avoid surface defects from glass to glass contact. The thickness was measured at the corners without touching the central portion of the specimen. Width measurements, when required, were taken with equal care.

Surface Compression Via DSR Readings

DSR readings were made in the center of each tempered sample on the surface with the cutter marks. The surface on which the DSR readings were made was the side that would be under compression during the destructive tests. This was done in order to eliminate the possibility of affecting the results of the destructive testing by contacting, and possibly damaging, the side to be placed under tension. It was assumed that the surface stress in the central portion of each sample would be essentially isotropic and equal from side to side. No less than four, and in general, five readings were made on each sample and the average value was used, by means of the calibration value, to determine the surface compression in psi.

Center Tension Measurements

Although not required in this investigation, center tension measurements were made to provide additional information for those accustomed to gaging the degree of temper by this means. Measurements were made using a quartz wedge graduated to read relative retardation in millimicrons. For the strips, 3 x 13 in., the measurements were made across the width in the center of each sample. The square samples were measured across diagonally opposite corners, along a 2 in. optical path for the 6-1/8 in. squares, and along a 4 in. optical path for the 12-1/4 in. square samples. The 4 in. squares of Chemcor and Herculite II were measured through the whole width of the samples. This data was converted to psi by using the following conversion factors provided by the manufacturers.

TABLE 3
BIREFRINGENCE CONSTANTS

Glass Type	Manufacturer and Code Number	Birefringence Constant psi/mmu/in.
Type I MIL-G-25667	PPG Polished Plate	2.13
Chemcor	Corning 0311	2.28
Alumino Silicate	PPG 6695	2.17
Herculite II	PPG 7265	2.26

Using this information of the center tension and the values obtained for the surface compression via the DSR, the ratio of the surface compression to the center tension was calculated for each type glass in their various states of temper. These results are summarized in Table 4. More detailed information is contained in Appendix II, Individual Testing Results.

Destructive Strength Tests

The strength of the annealed and tempered specimens was measured by either a modified beam loading method or a concentric ring method. Both of these testing methods have been in use at the Glass Research Center for the past 15 to 20 years. The beam loading method involves loading to breakage,

rectangular specimens simply supported near each end and loaded at two points symmetrically placed about the center. In the concentric ring method, a square plate is loaded by a circular member which moves coaxially to a support ring. The details of these methods are contained in Appendix I.

DESTRUCTIVE STRENGTH TEST RESULTS AND CORRELATION

Results

The results of the destructive strength tests and the results of the measurements of the surface compression and center tension are summarized in Table 4. The results listed in this table indicate that the principle of surface refractometry, as used in the DSR, the MDSR-I, and the MDSR-II, to measure surface compression of tempered glass is capable of predicting the breaking strength to within ±10% for seventy per cent of the samples tested and to within ±15% for the entire testing program. The average of the percentage deviation from breaking stress is -2.6% with the sign of the deviation taken into account. The mean of the absolute values of the per cent deviation, however, is 8.1%.

Tables of individual testing results are contained in Appendix II.

Discussion of Results

The agreement of the equation

$$\left\{\begin{matrix}\text{Basic}\\ \text{Strength}\end{matrix}\right\} + \left\{\begin{matrix}\text{DSR Reading of}\\ \text{Surface Compression}\end{matrix}\right\} = \left\{\begin{matrix}\text{Modulus of}\\ \text{Rupture}\end{matrix}\right\}$$

to within 10% certainly indicates the validity of surface refractometry, as exemplified in the stress instruments used in this study, as a means of assessing the strength of tempered glass. With instrumentation of this type, it is now possible to specify and control the strength of tempered glass of a given production process without the need of extensive destructive testing. That is, once a DSR instrument has been calibrated for a particular glass and the basic strength of this glass determined, this report shows that the strength of the tempered product can be determined nondestructively with statistical certainty.

CONCLUSIONS

The Differential Surface Refractometer, an instrument based on the principles of surface refractometry, and modifications of this instrument as required to extend its usefulness to other glass types, is capable of determining the magnitude of the surface compression, in psi, present on tempered glass by nondestructive means. Since the strength of glass is dependent upon the strength of its surface, this ability to measure the surface compression of tempered glass enables one to assess the strength of this glass without the need for destructive tests.

This report has demonstrated the correlation of the DSR readings with the strength of tempered glass of four different compositions in a variety of configurations. Specifically, the glass types and the stress instruments which were correlated are:

Type I MIL-G-25667 glass, PPG Polished Plate, and the DSR;
Chemcor Glass, Corning Glass Company Code 0311, and the MDSR-I;
Herculite II Glass, PPG No. 7265, and the MDSR-I;
Alumino Silicate, PPG No. 6695, and the MDSR-II.

TABLE 4

SUMMARIZED DESTRUCTIVE STRENGTH TEST RESU

Glass Type	Number of Samples Tested	Number of Edge Breaks	Sample Size	Testing Method	Mean Center Tension
Chemcor	51	0	1/10 x 4 x 4	CR 1-1/2 x 3	6530
Herculite II, Annealed	44	0	1/10 x 4 x 4	CR 1-1/2 x 3	30
Herculite II	51	0	1/10 x 4 x 4	CR 1-1/2 x 3	6950
Polished Plate, Annealed	27	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, Annealed	28	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, Annealed	29	16	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, Annealed	-	-	Same data as above but neglecting edge breaks		
Polished Plate, Annealed	22	13	3/4 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, Annealed	-	-	Same data as above but neglecting edge breaks		
Polished Plate, Annealed	29	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	235
Polished Plate, Annealed	31	4	3/4 x 12-1/4 x 12-1/4	CR 6 x 12	311
Polished Plate, 1/2 Temper	28	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, 1/2 Temper	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	4060
Polished Plate, 1/2 Temper	25	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	4310
Polished Plate, 1/2 Temper	26	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	4480
Polished Plate, 3/4 Temper	25	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6	
Polished Plate, 3/4 Temper	26	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	6430
Polished Plate, 3/4 Temper	27	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	5090
Polished Plate, 3/4 Temper	27	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	5320
Polished Plate, Full Temper	27	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6	6870
Polished Plate, Full Temper	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	7160
Polished Plate, Full Temper	26	3	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	7850
Polished Plate, Full Temper	-	-	Same data as above but neglecting edge breaks		
Polished Plate, Full Temper	25	7	3/4 x 6-1/8 x 6-1/8	CR 3 x 6	8190
Polished Plate, Full Temper	-	-	Same data as above but neglecting edge breaks		
Polished Plate, Full Temper	25	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	7440
Polished Plate, Full Temper	26	0	3/4 x 12-1/4 x 12-1/4	CR 6 x 12	8100
Alumino Silicate, Annealed	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	225
Alumino Silicate, Annealed	22	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	343
Alumino Silicate, 1/2 Temper	22	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	3970
Alumino Silicate, 1/2 Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	3480
Alumino Silicate, 3/4 Temper	20	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	5190
Alumino Silicate, 3/4 Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	5540
Alumino Silicate, Full Temper	21	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	7750
Alumino Silicate, Full Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	7400
Polished Plate, Annealed	31	6	3/16 x 3 x 13	Beam 4 x 12	147
Polished Plate, Annealed	28	13	1/4 x 3 x 13	Beam 4 x 12	142
Polished Plate, Annealed	28	11	1/2 x 3 x 13	Beam 4 x 12	256
Polished Plate, Annealed	25	25	3/4 x 3 x 13	Beam 4 x 12	171
Polished Plate, 1/2 Temper	24	12	3/16 x 3 x 13	Beam 4 x 12	4030
Polished Plate, 1/2 Temper	25	21	1/4 x 3 x 13	Beam 4 x 12	4030
Polished Plate, 1/2 Temper	25	16	1/2 x 3 x 13	Beam 4 x 12	4360
Polished Plate, 3/4 Temper	25	11	3/16 x 3 x 13	Beam 4 x 12	5320
Polished Plate, 3/4 Temper	25	24	1/4 x 3 x 13	Beam 4 x 12	5230
Polished Plate, 3/4 Temper	27	17	1/2 x 3 x 13	Beam 4 x 12	5290
Polished Plate, Full Temper	23	20	3/16 x 3 x 13	Beam 4 x 12	7700
Polished Plate, Full Temper	25	23	1/4 x 3 x 13	Beam 4 x 12	7350
Polished Plate, Full Temper	25	13	1/2 x 3 x 13	Beam 4 x 12	8640
Polished Plate, Full Temper	26	15	3/4 x 3 x 13	Beam 4 x 12	9640

Legend: CR - Concentric Ring Method, numbers following CR indicate the diameter of the rings in inch
Beam - Beam Loading Method, numbers following Beam indicate stress span and load span in inc

TABLE 4

TRUCTIVE STRENGTH TEST RESULTS AND CORRELATION

Testing Method	Mean Center Tension	Mean Surface Compression	Mean Surface on Center Ratio	Mean Breaking Stress	Standard Deviation	Range	Basic Strength Plus Surface Compression
CR 1-1/2 x 3	6530	45770	7.07	51180	7230	28200	
CR 1-1/2 x 3	30			14330	2780	11300	
CR 1-1/2 x 3	6950	56970	8.21	67010	6540	40000	71300
CR 3 x 6				10020	2310	9600	
CR 3 x 6				9270	2080	8900	
CR 3 x 6				7930	3090	9800	
neglecting edge breaks				10760	2430	9000	
CR 3 x 6				7410	4020	15400	
neglecting edge breaks				9580	4150	14700	
CR 6 x 12	235			10740	1200	4900	
CR 6 x 12	311			10570	2890	10200	
CR 3 x 6		8680		17980	3130	13000	18700
CR 3 x 6	4060	9800	2.41	21980	2560	9800	19070
CR 3 x 6	4310	9240	2.14	23420	4310	16900	20000
CR 6 x 12	4480	9920	2.22	23510	2150	7900	20660
CR 3 x 6		11160		22040	2620	11400	21180
CR 3 x 6	6430	15900	2.47	29360	3150	14100	25170
CR 3 x 6	5090	12540	2.47	27090	3380	14600	23300
CR 6 x 12	5320	12910	2.42	27460	2880	11500	23650
CR 3 x 6	6870	15270	2.22	26370	3280	13000	25290
CR 3 x 6	7160	17300	2.42	30780	2480	10100	26570
CR 3 x 6	7850	18980	2.32	29920	7130	27400	26910
neglecting edge breaks				31930	4544	15400	29740
CR 3 x 6	8190	23770	2.90	32060	11190	35800	31180
neglecting edge breaks				36930	7640	28400	33350
CR 6 x 12	7440	18810	2.53	32610	3350	14600	29550
CR 6 x 12	8100	23370	2.88	35990	3190	12000	33940
CR 3 x 6	225			10920	1840	7200	
CR 3 x 6	343			10970	1280	5000	
CR 3 x 6	3970	10340	2.61	19350	1830	8500	21260
CR 3 x 6	3480	10920	3.14	20790	2180	7300	21890
CR 3 x 6	5190	13410	2.58	24340	1780	7600	24330
CR 3 x 6	5540	17500	3.15	25690	3500	12000	28470
CR 3 x 6	7750	21150	2.73	30630	2220	10700	32070
CR 3 x 6	7400	23080	3.12	30250	3410	14200	34050
Beam 4 x 12	147			10940	2610	10400	
Beam 4 x 12	142			9050	1920	7200	
Beam 4 x 12	256			12410	2260	11000	
Beam 4 x 12	171			6670	3410	16400	
Beam 4 x 12	4030	9370	2.31	21570	2080	7800	20310
Beam 4 x 12	4030	9380	2.33	20250	2780	10500	18430
Beam 4 x 12	4360	10570	2.42	21470	2510	10400	22980
Beam 4 x 12	5320	11700	2.19	23750	2750	11100	22640
Beam 4 x 12	5230	11860	2.27	20360	2630	10700	20910
Beam 4 x 12	5290	13080	2.47	24590	3230	15900	25490
Beam 4 x 12	7700	17160	2.22	27040	2190	9700	28100
Beam 4 x 12	7350	17210	2.32	23700	2800	9700	26260
Beam 4 x 12	8640	21430	2.48	30860	3240	13100	33840
Beam 4 x 12	9640	26830	2.78	36500	3690	16300	33500

ameter of the rings in inches.
s span and load span in inches.

TABLE 4

SUMMARIZED DESTRUCTIVE STRENGTH TEST RESULTS AND CORRELA

Type	Number of Samples Tested	Number of Edge Breaks	Sample Size	Testing Method	Mean Center Tension	Mean Surface Compression	Me Su (Ce R
	51	0	1/10 x 4 x 4	CR 1-1/2 x 3	6530	45770	7.
nealed	44	0	1/10 x 4 x 4	CR 1-1/2 x 3	30		
	51	0	1/10 x 4 x 4	CR 1-1/2 x 3	6950	56970	8.
Annealed	27	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6			
Annealed	28	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6			
Annealed	29	16	1/2 x 6-1/8 x 6-1/8	CR 3 x 6			
Annealed	-	-	Same data as above but neglecting edge breaks				
Annealed	22	13	3/4 x 6-1/8 x 6-1/8	CR 3 x 6			
Annealed	-	-	Same data as above but neglecting edge breaks				
Annealed	29	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	235		
Annealed	31	4	3/4 x 12-1/4 x 12-1/4	CR 6 x 12	311		
1/2 Temper	28	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6		8680	
1/2 Temper	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	4060	9800	2.
1/2 Temper	25	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	4310	9240	2.
1/2 Temper	26	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	4480	9920	2.
3/4 Temper	25	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6		11160	
3/4 Temper	26	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	6430	15900	2.
3/4 Temper	27	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	5090	12540	2.
3/4 Temper	27	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	5320	12910	2.
Full Temper	27	0	3/16 x 6-1/8 x 6-1/8	CR 3 x 6	6870	15270	2.
Full Temper	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	7160	17300	2.
Full Temper	26	3	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	7850	18980	2.
Full Temper	-	-	Same data as above but neglecting edge breaks				
Full Temper	25	7	3/4 x 6-1/8 x 6-1/8	CR 3 x 6	8190	23770	2.
Full Temper	-	-	Same data as above but neglecting edge breaks				
Full Temper	25	0	1/2 x 12-1/4 x 12-1/4	CR 6 x 12	7440	18810	2.
Full Temper	26	0	3/4 x 12-1/4 x 12-1/4	CR 6 x 12	8100	23370	2.
, Annealed	25	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	225		
, Annealed	22	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	343		
, 1/2 Temper	22	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	3970	10340	2.
, 1/2 Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	3480	10920	3.
, 3/4 Temper	20	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	5190	13410	2.
, 3/4 Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	5540	17500	3.
, Full Temper	21	0	1/4 x 6-1/8 x 6-1/8	CR 3 x 6	7750	21150	2.
, Full Temper	21	0	1/2 x 6-1/8 x 6-1/8	CR 3 x 6	7400	23080	3.
nnealed	31	6	3/16 x 3 x 13	Beam 4 x 12	147		
nnealed	28	13	1/4 x 3 x 13	Beam 4 x 12	142		
nnealed	28	11	1/2 x 3 x 13	Beam 4 x 12	256		
nnealed	25	25	3/4 x 3 x 13	Beam 4 x 12	171		
/2 Temper	24	12	3/16 x 3 x 13	Beam 4 x 12	4030	9370	2.
/2 Temper	25	21	1/4 x 3 x 13	Beam 4 x 12	4030	9380	2.
/2 Temper	25	16	1/2 x 3 x 13	Beam 4 x 12	4360	10570	2.
/4 Temper	25	11	3/16 x 3 x 13	Beam 4 x 12	5320	11700	2.
/4 Temper	25	24	1/4 x 3 x 13	Beam 4 x 12	5230	11860	2.
/4 Temper	27	17	1/2 x 3 x 13	Beam 4 x 12	5290	13080	2.
ull Temper	23	20	3/16 x 3 x 13	Beam 4 x 12	7700	17160	2.
ull Temper	25	23	1/4 x 3 x 13	Beam 4 x 12	7350	17210	2.
ull Temper	25	13	1/2 x 3 x 13	Beam 4 x 12	8640	21430	2.
ull Temper	26	15	3/4 x 3 x 13	Beam 4 x 12	9640	26830	2.7

centric Ring Method, numbers following CR indicate the diameter of the rings in inches.
eam Loading Method, numbers following Beam indicate stress span and load span in inches.

BLE 4
GTH TEST RESULTS AND CORRELATION

Mean Center Tension	Mean Surface Compression	Mean Surface on Center Ratio	Mean Breaking Stress	Standard Deviation	Range	Basic Strength Plus Surface Compression	% Deviation from Breaking Stress
6530	45770	7.07	51180	7230	28200		
30			14330	2780	11300		
6950	56970	8.21	67010	6540	40000	71300	+ 6.4
			10020	2310	9600		
			9270	2080	8900		
			7930	3090	9800		
e breaks			10760	2430	9000		
			7410	4020	15400		
e breaks			9580	4150	14700		
235			10740	1200	4900		
311			10570	2890	10200		
	8680		17980	3130	13000	18700	+ 4.0
4060	9800	2.41	21980	2560	9800	19070	-13.2
4310	9240	2.14	23420	4310	16900	20000	-14.6
4480	9920	2.22	23510	2150	7900	20660	-12.1
	11160		22040	2620	11400	21180	- 3.9
6430	15900	2.47	29360	3150	14100	25170	-14.3
5090	12540	2.47	27090	3380	14600	23300	-14.0
5320	12910	2.42	27460	2880	11500	23650	-13.9
6870	15270	2.22	26370	3280	13000	25290	- 4.1
7160	17300	2.42	30780	2480	10100	26570	-13.7
7850	18980	2.32	29920	7130	27400	26910	-10.1
breaks			31930	4544	15400	29740	- 6.9
8190	23770	2.90	32060	11190	35800	31180	- 2.8
breaks			36930	7640	28400	33350	- 9.7
7440	18810	2.53	32610	3350	14600	29550	- 9.4
8100	23370	2.88	35990	3190	12000	33940	- 5.7
225			10920	1840	7200		
343			10970	1280	5000		
3970	10340	2.61	19350	1830	8500	21260	+ 9.9
3480	10920	3.14	20790	2180	7300	21890	+ 5.3
5190	13410	2.58	24340	1780	7600	24330	- 0.1
5540	17500	3.15	25690	3500	12000	28470	+10.8
7750	21150	2.73	30630	2220	10700	32070	+ 4.7
7400	23080	3.12	30250	3410	14200	34050	+12.6
147			10940	2610	10400		
142			9050	1920	7200		
256			12410	2260	11000		
171			6670	3410	16400		
4030	9370	2.31	21570	2080	7800	20310	- 5.9
4030	9380	2.33	20250	2780	10500	18430	- 9.0
4360	10570	2.42	21470	2510	10400	22980	+ 7.0
5320	11700	2.19	23750	2750	11100	22640	- 4.7
5230	11860	2.27	20360	2630	10700	20910	+ 2.7
5290	13080	2.47	24590	3230	15900	25490	+ 3.7
7700	17160	2.22	27040	2190	9700	28100	+ 3.9
7350	17210	2.32	23700	2800	9700	26260	+10.8
8640	21430	2.48	30860	3240	13100	33840	+ 9.7
9640	26830	2.78	36500	3690	16300	33500	- 8.2

rings in inches.
d span in inches.

STUDY OF LIMITATIONS

The limitations of the DSR, in its basic design, with respect to the effects of curvature, waviness, edge proximity, and surface finish were determined by direct examination. Initially it was assumed that glass composition would not affect the limitations of the DSR and this work was carried out using only Type I MIL-G-25667 glass. However, in the extension of the basic design to the other glass types, especially Chemcor and Herculite II, there is reason to believe that the limitations of the DSR may not, in general, apply to the MDSR-I and MDSR-II instruments.

Curvature

The limitations of the DSR with respect to surface curvature were determined on four basic surface types: (1) concave cylindrical; (2) convex cylindrical; (3) concave spherical; and (4) convex spherical. In the case of cylindrically bent glass the limitations must be established for two orientations, one, when the optical axis of the instrument is oriented parallel to the cylinder axis, and the other, when the optical axis is oriented perpendicular to the cylinder axis. Thus, a total of six cases have been studied.

The limiting radius for each case was based on the quality of the stress image observed in the DSR telescope, i.e., the point at which the image quality deteriorates to a degree sufficient to affect the readability of the instrument. Also, the radius of curvature at which the stress image disappears, or becomes impractical to read due to large variations, was determined in each case. The results of this study are listed in the following table:

TABLE 5
CURVATURE LIMITATIONS

Surface	R_1	R_2
Concave Spherical	175 in.	100 in.
Convex Spherical	250 in.	125 in.
Concave Cylindrical parallel to Axis	<5 in.	-*
Concave Cylindrical perpendicular to Axis	200 in.	150 in.
Convex Cylindrical parallel to Axis	100 in.	5 in.
Convex Cylindrical perpendicular to Axis	150 in.	100 in.

Legend:

R_1 - Radius of curvature at which stress image quality begins to deteriorate.

R_2 - Limiting radius of curvature

* - This limit has not been established but would be less than 5.

At the limiting radius, R_2, the stress image may be poor, but it is still possible to determine the surface stress with a reasonable amount of accuracy. Beyond this point, the stress readings become impractical with the DSR in its present design. The term "reasonable amount of accuracy" is relative and may be given more meaning when considered in light of the following remarks.

When several readings are taken with the DSR at one location on a flat sample of fully tempered glass, a variation in the readings of 2-3% is normal. In the above work on curved surfaces, when the variation in readings approached 10-15%, the author considered this to be "reasonably accurate". Beyond this point, the usefulness of the DSR, in its present design, would have to be determined by the application.

The variation in readings is not affected by a deterioration of the stress image as much as by a tendency to wobble or rock on the curved surfaces. This rocking can be corrected by proper changes in the design of the DSR instrument.

Other Limitations

The limitations of the DSR with respect to waviness, edge proximity, and surface finish were determined for flat samples only. These results are summarized below.

Waviness: This will not be a problem in the use of the DSR on aircraft quality glass since the waviest sheet glass is readable.

Edge Proximity: The limitation on edge proximity is the prism contact length, i.e., as long as the length of the prism is in contact, readings may be made at the edge of a sample. When making readings at an edge, however, it must be remembered that the stress is no longer isotropic in this region and that the stress instrument reads the surface stress in a direction 90° to its optical axis.

Surface Finish: Short finish presents no problem - as the DSR is capable of reading through surfaces ground to a matte finish with 800X abrasive.

REFERENCES

(1) The theory of operation of the DSR is discussed in Progress Report No. 1. Ansevin, R. W. and French, P. W., Correlation of the DSR with the Strength of Glass of Different Compositions and Configurations, Progress Report No. 1. Covering the period 1 July 1963 to 30 September 1963.

(2) Timoshenko, S., Strength of Materials, Part I, Second Edition, D. Van Nostrand, New York, 1940, p. 61.

(3) Roark, R. J., Formulas for Stress and Strain, Second Edition, McGraw-Hill, New York, 1943, p. 189.

(4) Vitman, F. F., Bartenev, G. M. Pukh, V. P., and Tsepkov, L. P., A Method for Measuring the Strength of Sheet Glass, Translated from Steklo i Keramika, Vol. 19, No. 8, pp. 9-11, August, 1962.

(5) Vitman, F. F., and Pukh, V. P., A Method for Determining the Strength of Sheet Glass, Translated from Zavodskaya Laboratoriya, Vol. 29, No. 7, pp. 863-867, July, 1963.

APPENDIX I

DETAILED PROCEDURE

CALIBRATION

Calibration Methods

Type I MIL-G-25667: The calibration of the DSR for Type I MIL-G-25667 glass (polished plate) was determined by subjecting 10 fully tempered samples, of size 6 x 24 x 1/2 in., to beam bending using a Baldwin Testing Machine. Each sample was simply supported, with a load span of 22 in. and a stress span of 6 in., in such a manner that the surface which would experience the tension during the test was in a convenient position for examination with the DSR. The DSR was placed on the sample in the area over the 6 in. stress span and oriented to detect the resultant surface stress due to loading. The DSR reads the surface stress in a direction 90° to the optical axis of the instrument. At zero load the DSR reading corresponds to the magnitude of the surface compression introduced during the tempering process. Loading was applied in suitable increments until the surface being examined was in tension; the degree of this tension was held to a level below the expected rupture point in order to avoid sample failure. At each load increment, the corresponding DSR reading was noted by taking several measurements.

The average DSR readings were then plotted against the surface stresses calculated from beam bending theory, see Calculation of Bending Stresses, Appendix I. From this data, the surface compression at zero load was determined by passing a line of least squares through the points recorded. This value obtained for the surface compression at zero load divided by the DSR reading for the same condition produced the calibration value, K, in psi per micrometer eyepiece unit for each sample. The data for a typical sample is illustrated in Figure 1. The linear relationship between the surface compression and the DSR reading is quite evident in this illustration.

The results of examining these ten samples of Type I MIL-G-25667 glass determined the mean calibration value of the DSR for this glass to be 60.18 psi per eyepiece unit with a standard deviation of 0.41. The stress-optic constant, C, was found to be 5.4×10^7 psi per unit birefringence. This is an average result for the ten samples.

The pertinent data of the calibration study for this and the other glass types is contained in Table 6. Figures 1 through 4 illustrate the linear relationship between the surface stress and the DSR readings for each type glass.

Chemcor: The characteristics of this glass differ greatly from those of polished plate for which the basic DSR was designed. Therefore a different version of the DSR was required to measure the surface compression of this glass. This version is termed the Modified Differential Surface Refractometer-I or MDSR-I. Also, due to the sample size and thickness limitations at the time this glass was procured, a considerably smaller sample in comparison to the sample size of 6 x 24 x 1/2 in. used for polished plate, was used in

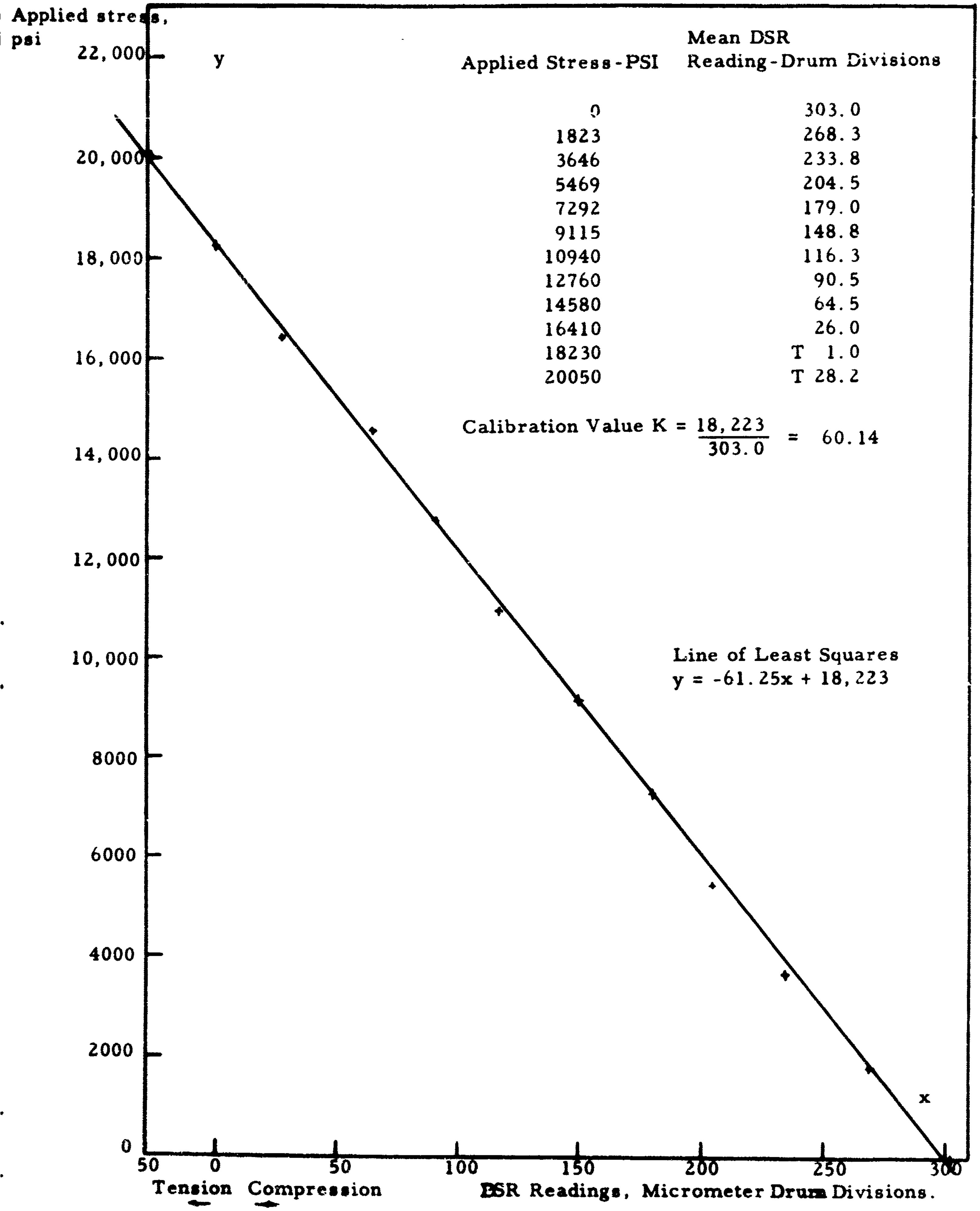


Figure 1 - Representative Calibration Results for Type 1 MIL-G-25667 Glass (Polished Plate).

the calibration procedure. The size was nominally 2 x 7 x 1/8 in. Twenty samples of fully tempered Chemcor were examined by subjecting them to beam bending with a load span of 6 in. and a stress span of 2 in. Loading was applied using a Instron Testing Machine. Due to the small sample thickness, it was not possible to continue taking MDSR-I readings until the surface was placed in tension as was done in the calibration of Type I MIL-G-25667 glass. The sample curvature became excessive after about 2/3 of the surface compression was removed by loading with a subsequent deterioration in the quality of the stress image. As a result of this deterioration, loading had to be discontinued before the surface was placed in tension. Consequently, the surface compression at zero load had to be determined by extrapolating the line of least squares for the points recorded. This need to extrapolate introduced a greater variation in the results as evidenced by a larger standard deviation in comparison with the results for Type I MIL-G-25667 glass. The results of examining these twenty samples of Chemcor glass determined the mean calibration value for the MDSR-I to be 173.4 psi per eyepiece unit with a standard deviation of 13. The stress optic constant, C, for the surface layers of this glass was found to be 4.4×10^7 psi/unit birefringence.

As in the case of the Type I MIL-G-25667 glass, there is a strong linear relationship between the surface compression and the MDSR-I readings for Chemcor glass, see Figure 2.

Alumino Silicate: The characteristics of this glass also differ from those of polished plate to a degree sufficient to require a different version of the DSR in order to measure the surface compression. This model is termed the Modified Differential Surface Refractometer-II or MDSR-II. Otherwise the calibration procedure was identical to that described for the calibration of Type I MIL-G-25667 glass. Ten fully tempered samples 6 x 24 x 1/2 in. were examined. The mean calibration value of the MDSR-II for this glass was determined to be 167.2 psi per eyepiece unit with a standard deviation of 2.5. Figure 3 contains an illustration of the calibration results of a typical sample.

Herculite II: The same version of stress instrument as used on Chemcor, the MDSR-I, was used in determining the calibration value of this glass. The same procedure and technique as used with the Chemcor glass was applied here. Twenty samples, 2 x 7 x 3/16 in., of fully tempered Herculite II were examined. The mean calibration value of this data is 189.3 psi per eyepiece unit with a standard deviation of 11. The calibration results for a typical sample are illustrated in Figure 4. Further data is contained in Table 6.

Index Measurements

The surface refractive indices, $n_{\parallel}$ and $n_{\perp}$, for light polarized parallel and perpendicular to the surface of the sample, respectively, were measured for all calibration samples, see Table 6. The surface indices for the large, 6 x 24 in., samples were measured using the corresponding stress instrument for that glass. Surface refractive indices can be measured with the stress instruments by using a glass sample of known index as a reference. The surface refractive index, n, of a sample can be readily determined by noting the angle between the critically reflected image of the reference sample and

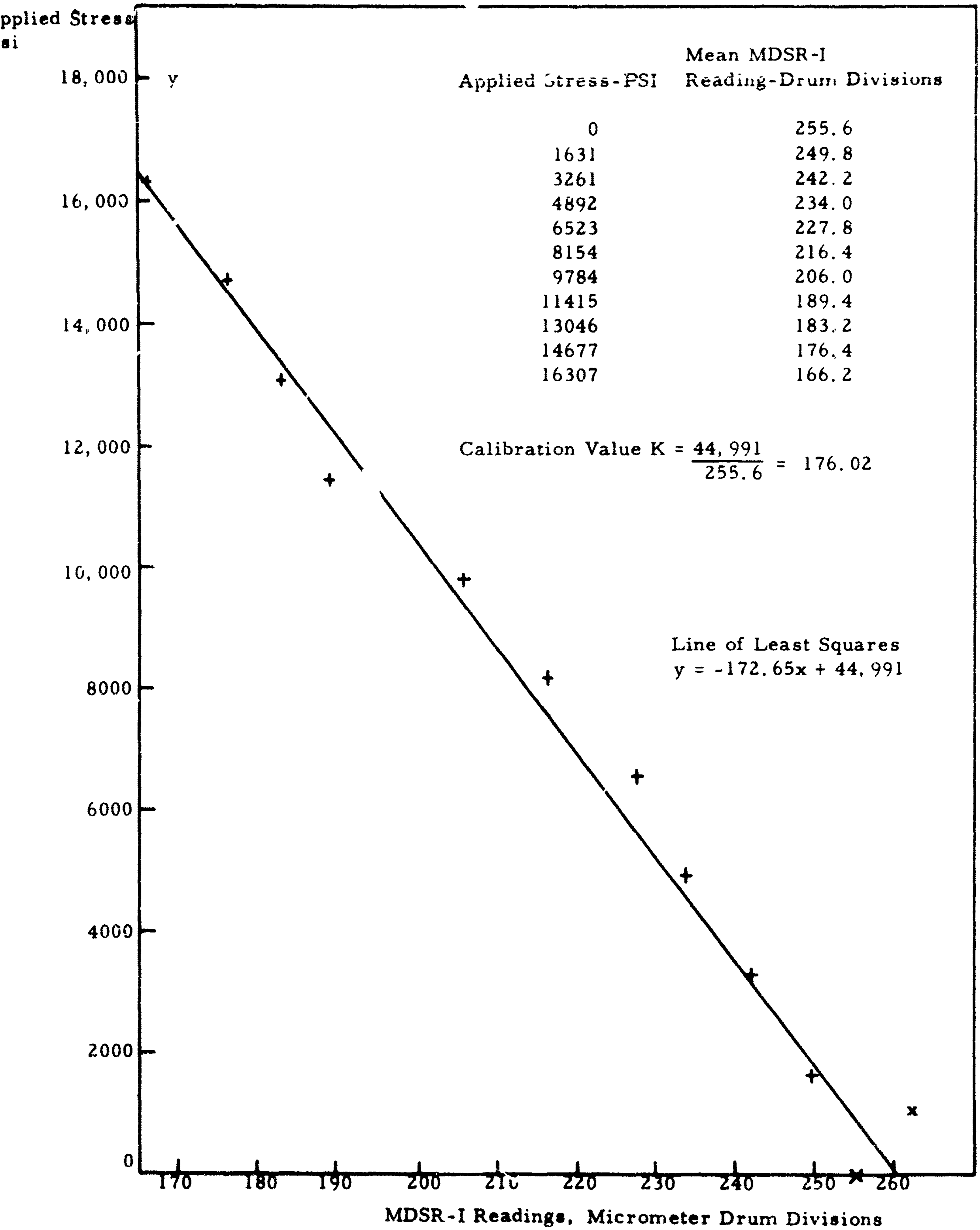
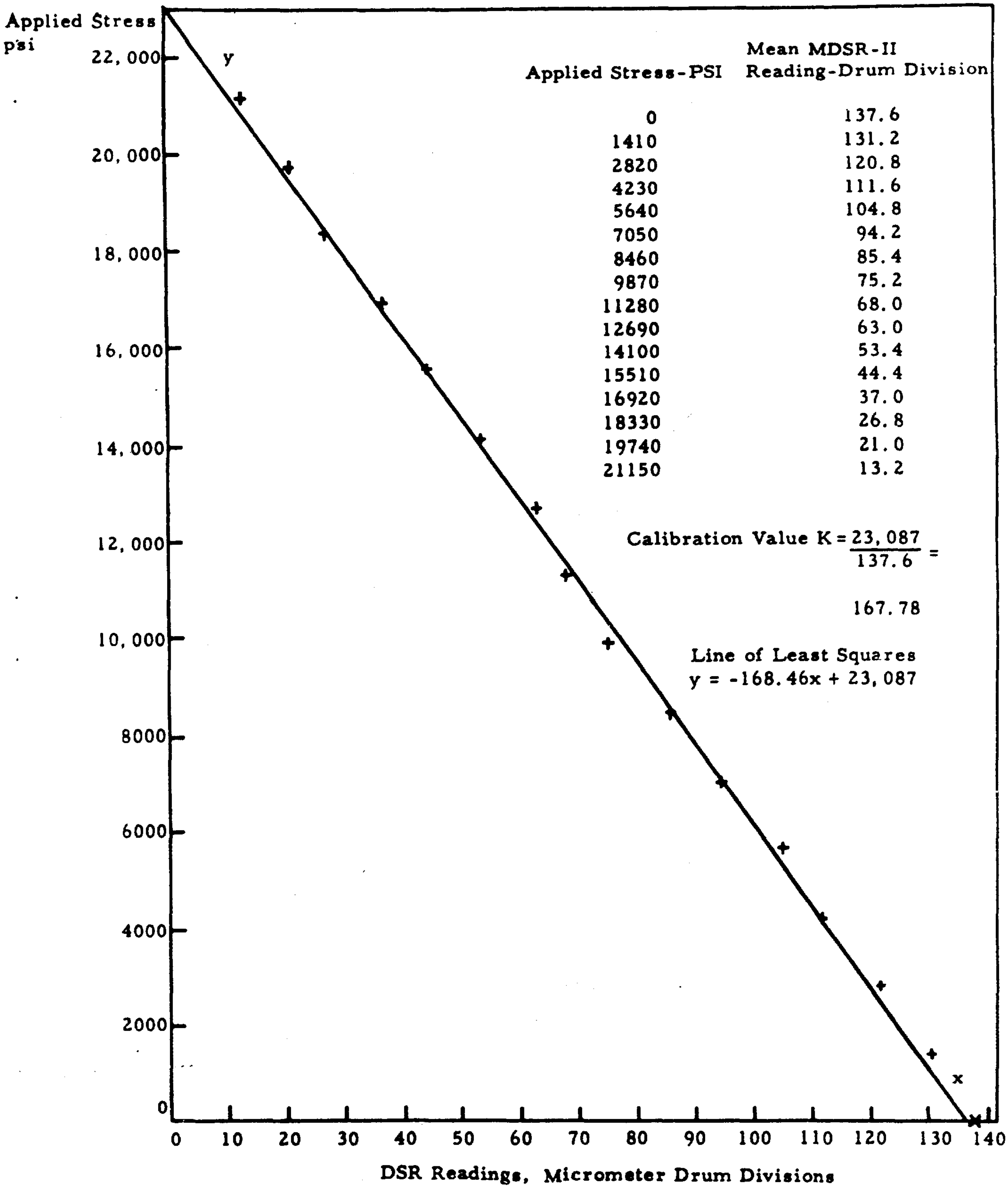
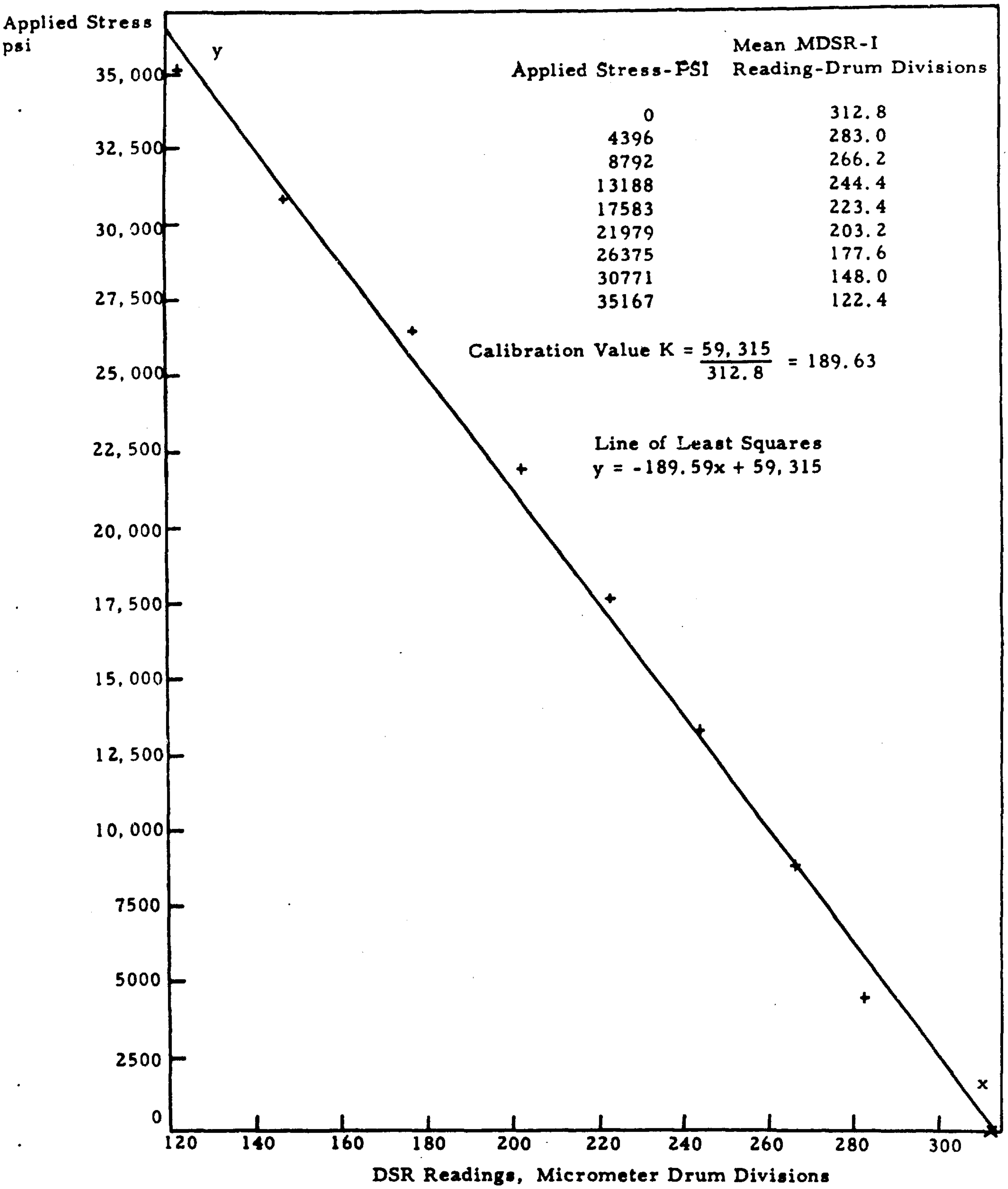


Figure 2 - Representative Calibration Results for Chemcor Glass



Applied Stress-PSI	Mean MDSR-II Reading-Drum Division
0	137.6
1410	131.2
2820	120.8
4230	111.6
5640	104.8
7050	94.2
8460	85.4
9870	75.2
11280	68.0
12690	63.0
14100	53.4
15510	44.4
16920	37.0
18330	26.8
19740	21.0
21150	13.2

Figure 3 - Representative Calibration Results for Alumino Silicate Glass



Applied Stress-PSI	Mean MDSR-I Reading-Drum Divisions
0	312.8
4396	283.0
8792	266.2
13188	244.4
17583	223.4
21979	203.2
26375	177.6
30771	148.0
35167	122.4

Figure 4 - Representative Calibration Results for Herculite II Glass

TABLE 6
CALIBRATION, SURFACE INDEX AND STRESS OPTICAL CONSTANT RESULTS

Glass Type	Stress Instrument	Sample Number	Surface Compression psi	Stressmeter Reading Eyepiece Units	Directly Measured Index Difference x 10^{-4}	Calibration Value K, psi/Eyepiece Unit	$n_\perp$	$n_\parallel$	Stress Optic Constant C x 10^8 psi/Unit Birefringence
Type I MIL-G-25667	DSR	PP-1	19073	314.3	3.52	60.68	1.5251	1.5247	542
Type I MIL-G-25667	DSR	PP-2	21969	362.0	4.05	60.69	1.5251	1.5248	542
Type I MIL-G-25667	DSR	PP-3	18021	301.8	3.38	59.71	1.5250	1.5246	533
Type I MIL-G-25667	DSR	PP-4	19656	325.3	3.64	60.42	1.5250	1.5246	540
Type I MIL-G-25667	DSR	PP-5	19296	321.3	3.60	60.06	1.5250	1.5246	536
Type I MIL-G-25667	DSR	PP-6	19446	322.0	3.61	60.39	1.5250	1.5246	539
Type I MIL-G-25667	DSR	PP-7	18223	303.0	3.39	60.14	1.5249	1.5246	538
Type I MIL-G-25667	DSR	PP-8	21918	365.5	4.09	59.97	1.5249	1.5244	536
Type I MIL-G-25667	DSR	PP-9	17537	296.0	3.32	59.25	1.5251	1.5247	528
Type I MIL-G-25667	DSR	PP-10	19135	316.5	3.54	60.46	1.5250	1.5246	540
						Mean 60.18	Mean 1.5250	Mean 1.5246	Mean 537
						SD 0.41			
Alumino Silicate	MDSR-II	AS-1	23854	147.4	4.22	161.83	1.5580	1.5576	565
Alumino Silicate	MDSR-II	AS-2	24521	144.2	4.12	173.82	1.5580	1.5575	595
Alumino Silicate	MDSR-II	AS-3	23870	144.6	4.14	165.36	1.5580	1.5576	576
Alumino Silicate	MDSR-II	AS-4	23928	145.2	4.15	164.79	1.5578	1.5576	576
Alumino Silicate	MDSR-II	AS-5	24871	149.6	4.28	166.25	1.5581	1.5576	581
Alumino Silicate	MDSR-II	AS-6	24172	143.8	4.11	168.09	1.5580	1.5576	588
Alumino Silicate	MDSR-II	AS-7	23087	137.6	3.94	167.78	1.5580	1.5576	586
Alumino Silicate	MDSR-II	AS-8	24337	141.4	4.04	172.12	1.5580	1.5576	602
Alumino Silicate	MDSR-II	AS-9	23906	140.4	4.02	170.27	1.5581	1.5576	595
Alumino Silicate	MDSR-II	AS-10	24031	145.0	4.15	165.73	1.5580	1.5576	579
						Mean 167.2	Mean 1.5580	Mean 1.5576	Mean 584
						SD 2.5			
Chemcor	MDSR-I	CC-1	40476	269.2	10.55	150.36	1.5127	1.5119	384
Chemcor	MDSR-I	CC-2	44121	272.8	10.69	161.73	1.5132	1.5122	413
Chemcor	MDSR-I	CC-3	44580	269.6	10.57	165.35	1.5130	1.5120	422
Chemcor	MDSR-I	CC-4	41241	263.6	10.33	156.45	1.5130	1.5120	399
Chemcor	MDSR-I	CC-5	41751	266.0	10.43	156.96	1.5130	1.5120	400
Chemcor	MDSR-I	CC-6	46426	274.0	10.74	168.11	1.5131	1.5121	432
Chemcor	MDSR-I	CC-7	44461	274.2	10.75	162.14	1.5132	1.5122	414
Chemcor	MDSR-I	CC-8	50003	269.6	10.57	185.47	1.5130	1.5120	473
Chemcor	MDSR-I	CC-9	43384	259.6	10.18	167.12	1.5132	1.5122	426
Chemcor	MDSR-I	CC-10	51104	271.8	10.65	188.02	1.5132	1.5121	480
Chemcor	MDSR-I	CC-11	49302	268.6	10.53	183.55	1.5130	1.5119	468
Chemcor	MDSR-I	CC-12	48378	269.4	10.56	179.58	1.5133	1.5122	458
Chemcor	MDSR-I	CC-13	53060	265.0	10.39	200.22	1.5127	1.5120	511
Chemcor	MDSR-I	CC-14	46778	261.4	10.25	178.95	1.5132	1.5121	456
Chemcor	MDSR-I	CC-15	44991	255.6	10.02	176.02	1.5130	1.5121	449
Chemcor	MDSR-I	CC-16	48169	270.0	10.58	178.40	1.5129	1.5120	455
Chemcor	MDSR-I	CC-17	48668	270.8	10.62	179.72	1.5131	1.5122	458
Chemcor	MDSR-I	CC-18	47552	262.6	10.29	181.08	1.5130	1.5120	462
Chemcor	MDSR-I	CC-19	49768	261.6	10.25	190.25	1.5128	1.5120	486
Chemcor	MDSR-I	CC-20	43018	272.8	10.69	157.69	1.5130	1.5120	402
						Mean 173.4	Mean 1.5130	Mean 1.5121	Mean 442
						SD 13.			
Herculite II	MDSR-I	H-1	56522	316.6	11.97	178.53	1.5153	1.5143	472
Herculite II	MDSR-I	H-2	61075	289.6	10.95	210.89	1.5153	1.5143	558
Herculite II	MDSR-I	H-3	51302	320.2	12.10	160.22	1.5153	1.5142	424
Herculite II	MDSR-I	H-4	57019	304.4	11.51	187.32	1.5152	1.5142	495
Herculite II	MDSR-I	H-5	58199	316.6	11.97	183.82	1.5151	1.5140	486
Herculite II	MDSR-I	H-6	58646	306.2	11.57	191.53	1.5152	1.5140	507
Herculite II	MDSR-I	H-7	57945	315.2	11.91	183.83	1.5152	1.5141	486
Herculite II	MDSR-I	H-8	55778	318.6	12.04	175.07	1.5153	1.5143	463
Herculite II	MDSR-I	H-9	63397	314.2	11.88	201.77	1.5153	1.5142	534
Herculite II	MDSR-I	H-10	61805	307.8	11.63	200.79	1.5153	1.5143	531
Herculite II	MDSR-I	H-11	60594	319.2	12.06	189.83	1.5154	1.5143	502
Herculite II	MDSR-I	H-12	61086	310.2	11.72	196.92	1.5152	1.5141	521
Herculite II	MDSR-I	H-13	57295	314.8	11.90	182.00	1.5152	1.5143	481
Herculite II	MDSR-I	H-14	62216	318.0	12.02	195.65	1.5156	1.5146	518
Herculite II	MDSR-I	H-15	64260	324.6	12.27	197.97	1.5153	1.5142	524
Herculite II	MDSR-I	H-16	59315	312.8	11.82	189.63	1.5153	1.5143	502
Herculite II	MDSR-I	H-17	61846	311.8	11.79	198.35	1.5151	1.5140	524
Herculite II	MDSR-I	H-18	58377	312.4	11.81	186.87	1.5152	1.5141	494
Herculite II	MDSR-I	H-19	60017	319.4	12.07	187.91	1.5154	1.5142	497
Herculite II	MDSR-I	H-20	59117	314.2	11.88	188.15	1.5152	1.5142	498
						Mean 189.3	Mean 1.5153	Mean 1.5142	Mean 501
						SD 11.			

Legend: $n_\parallel$ - Surface index of refraction for light polarized parallel to the plane of the surface.
$n_\perp$ - Surface index of refraction for light polarized perpendicular to the plane of the surface.
SD - Standard Deviation.

the critically reflected image of the sample being examined. For a stressed sample, two images will be formed, one corresponding to $n_{\parallel}$ and the other corresponding to $n_{\perp}$. The surface refractive index is given by

$$n = \sqrt{N^2 - \sin^2 \beta}$$

where N is the prism index of the stress instrument, and β is the emergent angle of the prism for a given sample, i.e., the angle at which the light leaves the prism as measured from the normal.

The surface indices for the smaller, 2 x 7 in., samples were measured by reflected light of the proper polarization using a Bausch and Lomb, Abbe-56 Refractometer. The proper polarization was attained by fitting the eyepiece of this instrument with a polarizing filter. By rotating the eyepiece 90°, the two indices, $n_{\parallel}$ and $n_{\perp}$, were measured directly.

The difference between the two surface refractive indices, $n_{\parallel} - n_{\perp}$, can be measured directly with the DSR in terms of eyepiece units. The following factors apply to each glass type and their respective stress instrument:

Type I MIL-G-25667 glass using the DSR, 1.12×10^{-6};
Chemcor glass using the MDSR-I, 3.92×10^{-6};
Herculite II glass using the MDSR-I, 3.78×10^{-6};
Alumino Silicate glass using the MDSR-II, 2.86×10^{-6}.

By multiplying the stressmeter reading, expressed in eyepiece units, by the proper factor, as determined above, we get the absolute value of the index change directly. These conversion factors are good only in the index ranges listed in Table 6.

DESTRUCTIVE STRENGTH TESTS

Testing Methods

The beam loading method involved loading to breakage of 3 x 13 in. specimens supported 1/2 in. from either end and loaded at the two points 4 in. from the supports. In the concentric ring method, a square plate was loaded by a circular member which moved coaxially to the support ring. Three different pairs of ring sizes were used on three different sample sizes: 3 and 6 in. diameter rings with 6-1/8 in. square samples; 6 and 12 in. diameter rings with 12-1/4 in. square samples; and 1-1/2 and 3 in. diameter rings with 4 in. square samples.

Both the beam loading and the concentric ring loading methods were used on the Type I MIL-G-25667 glass; then, on the basis of the results, the concentric ring method was selected for the other glass types. The concentric ring method was preferred over the beam loading method because of the large number of edge breaks encountered in the latter method. The evaluation of the strength of glass is a relatively complicated problem; it is known that the strength depends on a number of various edge and surface effects. Therefore, if the strength of glass with a specified surface treatment is to be

determined, it is necessary that the measured strength be characteristic of the properties of the surface layer alone and does not contain errors due to a possible effect of a weakened edge. The concentric ring method, of proper design, excludes the effect of edge defects from the results of strength measurements.

In reference to concentric ring tests of proper design, it was initially intended that only the 3 and 6 in. diameter rings be used to test the Type I MIL-G-25667 glass in all thicknesses, however, a large number of edge breaks were encountered in the testing of the 1/2 in. and 3/4 in. thicknesses. As this testing method is intended to eliminate the edge effects during strength measurements, larger samples were prepared to determine if this may have been the result of the small sample size relative to thickness for these groups. Samples 12-1/4 in. square were tested on a 12 in. diameter support ring with a 6 in. diameter load ring. The results show that this corrected the problem. Another way to eliminate this type of break would be to have the sample extend beyond the support ring by a greater amount. When the latter method is used, however, corrections for the overhang have to be included in the calculation of the breaking stress.

Testing Techniques

Specimens having cut edges were broken with the cutter marks on the side under compression. This surface was taped in order to preserve the origin of failure. Loading rates were in the range of 4000 to 15000 psi per minute depending on the available loading rates of the testing machines used. The loading rate used for a given test, however, was held constant to within ±1000 psi per minute. When possible, a loading rate of 5000 psi per minute was used. These are the loading rates which were maintained during the latter half of the destructive tests. When necessary, in order to keep testing times within a reasonable length, specimens were fast loaded to approximately 50% of the rupture strength. The temperature and humidity were held within certain limits during the tests and at least 48 hours previous to the tests. The temperature was maintained between 70-75°F and the relative humidity did not exceed 50%. A minimum of 20, and in general, 25 samples were tested for each category listed in Table 1. Approximately 50 samples, however, were used in the testing of glass types Chemcor and Herculite II.

Each sample was examined for defects which could possibly affect its strength. Samples which contained defects that are not normally representative of that type sample were rejected.

The location of the fracture origin and the direction of the maximum stress were noted for all samples. If a fracture origin occurred outside of the area of maximum stress, the breaking stress was given the value of the stress at the position of the origin rather than the maximum stress the sample experienced. The methods used in determining this value of stress are listed in the following section.

The amount of center deflection of each group of samples tested by the concentric ring method was monitored in order to detect the presence of membrane stresses. When the deflection of the center exceeded half the sample thickness, the degree of membrane stress was estimated and the breaking

stress corrected to eliminate this effect. Groups of samples for which this occurred will have both the breaking stress including membrane effects and the corrected breaking stress listed in the tables of individual testing results. These tables are contained in Appendix II. This effect was found to occur only in the thin glass samples which were subjected to high loads: 3/4 and full tempered 3/16 in.-thick Type I MIL-G-25667 glass; full tempered 1/10 in.-thick Chemcor; and full tempered 1/10 in.-thick Herculite II.

Calculation of Bending Stresses

The data resulting from the destructive tests and the calibration study was converted into maximum surface stress by use of the following formulas solved from bending theory[2][3][4][5]:

Rectangular Specimens (Beam Bending)

$$\sigma_{max.} = 3/2 \frac{PL}{wt.^2} \qquad (2)$$

where $\sigma_{max.}$ = maximum surface stress within stress span, psi

P = load in pounds

L = effective span, i.e., the load span minus the stress span, in inches

w = width of specimen in inches

t = thickness of specimen in inches

Square Specimens (Concentric Rings of 2:1 Ratio)[3][4][5]

$$\sigma_{max.} = 0.545 \frac{P}{t^2} \qquad (3)$$

This formula, however, is not corrected for overhang while the following three are corrected[4][5]:

1. Formula for 6-1/8 in. square samples on 3 and 6 in. diameter rings.

$$\sigma_{max.} = 0.511 \frac{P}{t^2}$$

2. Formula for 12-1/4 in. square samples on 6 and 12 in. diameter rings.

$$\sigma_{max.} = 0.510 \frac{P}{t^2}$$

3. Formula for 4 in. square samples on 1-1/2 and 3 in. diameter rings.

$$\sigma_{max.} = 0.463 \frac{P}{t^2}$$

where $\sigma_{max.}$ = maximum surface stress within the load ring, psi

P = load in pounds

t = thickness of the specimen in inches

Corrections for Fracture Origins Outside Maximum Stress Area

The value calculated for the maximum stress at which a sample failed was reduced by a "fracture origin factor" whenever the fracture originated outside of the maximum stress area. The graph in Figure 5 was used for the 3 x 13 in. beam loading specimens(2) while the graph in Figure 6 was used for the concentric ring loading specimens(3). In the concentric ring loading specimens, whenever the direction of the fracture stress was at some angle to the tangential and radial stresses, the fracture origin factor was estimated by interpolating between the two curves of Figure 6.

Corrections for Membrane Stress in Concentric Ring Testing

Whenever large deflections are required to cause failure of a sample, i.e., whenever the deflection at the center of the glass exceeds half its thickness, a method of estimating the breaking stress which excludes membrane effects is more desirable than the misleading large strengths given by the formulas 1, 2, and 3. The theory for the concentric ring loading method from which these formulas were derived assumes small deflections and pure bending of the center portion of the plate. For large deflections, the glass may stretch like a membrane as well as bend, giving rise to membrane stresses. Since the mathematical methods for treating membrane stresses are cumbersome and lengthy, an empirical approach was used to estimate this effect.

It is known from the existing theory that for pure bending the load is proportional to the deflection, while for pure membrane stressing the load is proportional to the cube of the deflection. Thus when a sample requires a deflection of greater than half its thickness to cause failure, an examination of the graph of the load versus deflection in the region beyond the half thickness will show a nonlinearity due to the presence of membrane stresses. A correction factor for this membrane stress was estimated by forming a ratio of the linear portion of the load at failure, determined by an extension

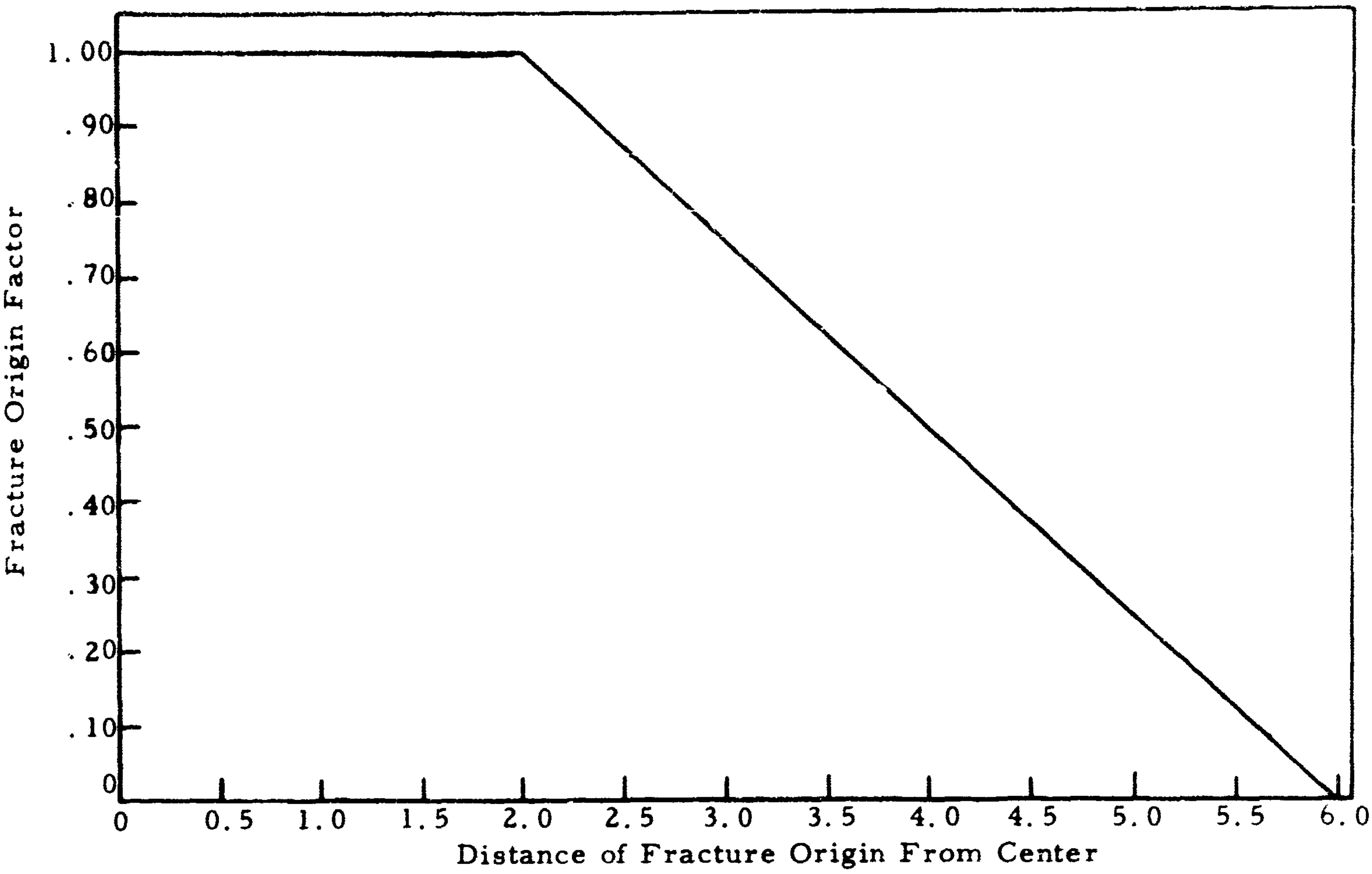


Figure 5 - Corrections for Fracture Origins Outside Maximum Stress Area for 4 and 12 In. Span Beam Loading Method

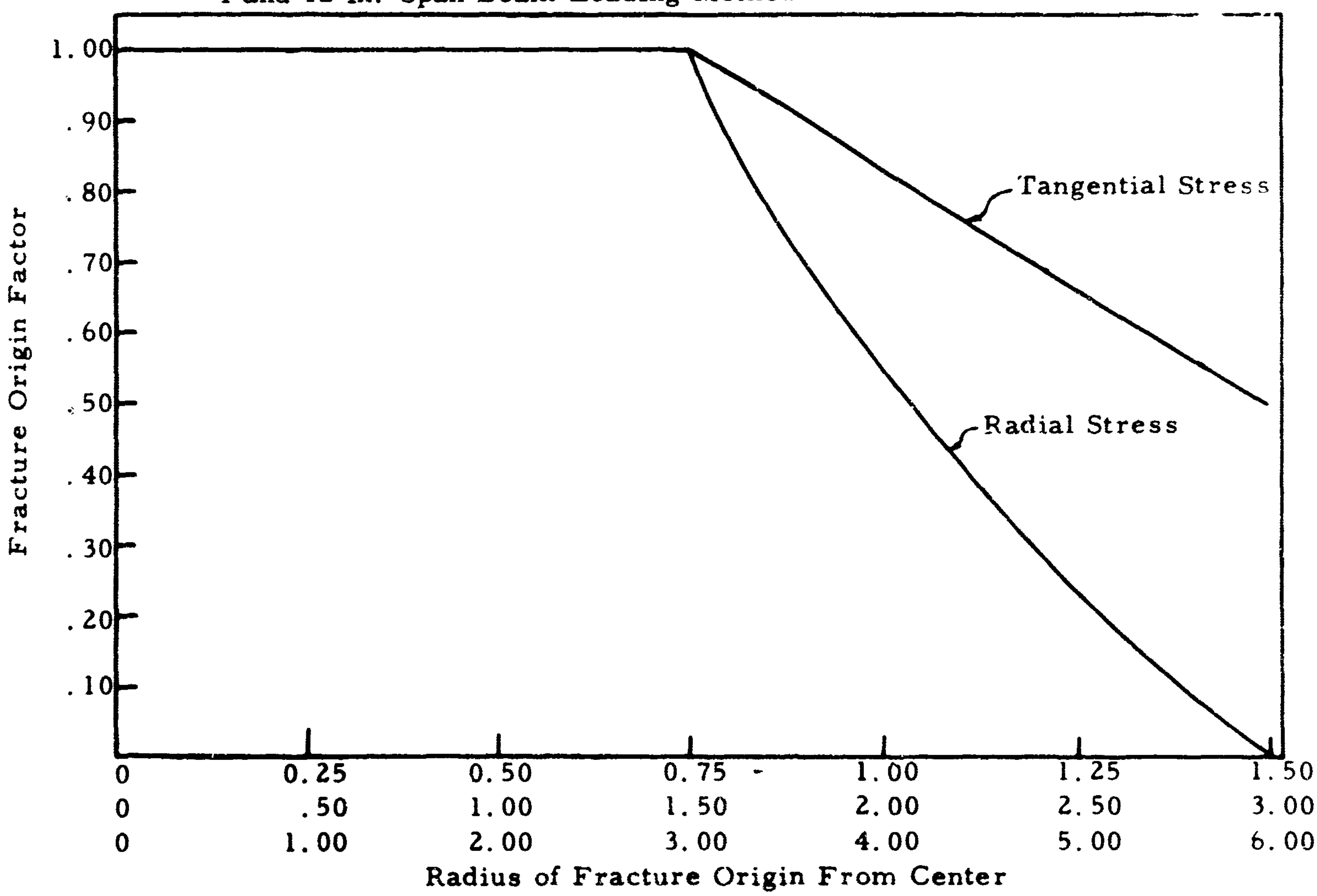


Figure 6 - Corrections for Fracture Origins Outside Maximum Stress Area for Concentric Ring Loading Method

of the linear load-deflection curve, divided by the actual load at failure. For a given group of samples, several estimates of the correction factor were made and the average value used to determine the corrected breaking stresses for the entire group. By this method, correction factors were determined for the following groups of samples which showed membrane effects: 3/4 and full tempered 3/16 in.-thick Type I MIL-G-25667 glass - a correction factor of 0.9; full tempered 1/10 in.-thick Chemcor and Herculite II - a correction factor of 0.8. Figure 7 illustrates the method as applied to a sample of full tempered Herculite II. These samples were tested on the Instron Testing Machine which gives a measure of the load ring deflection directly.

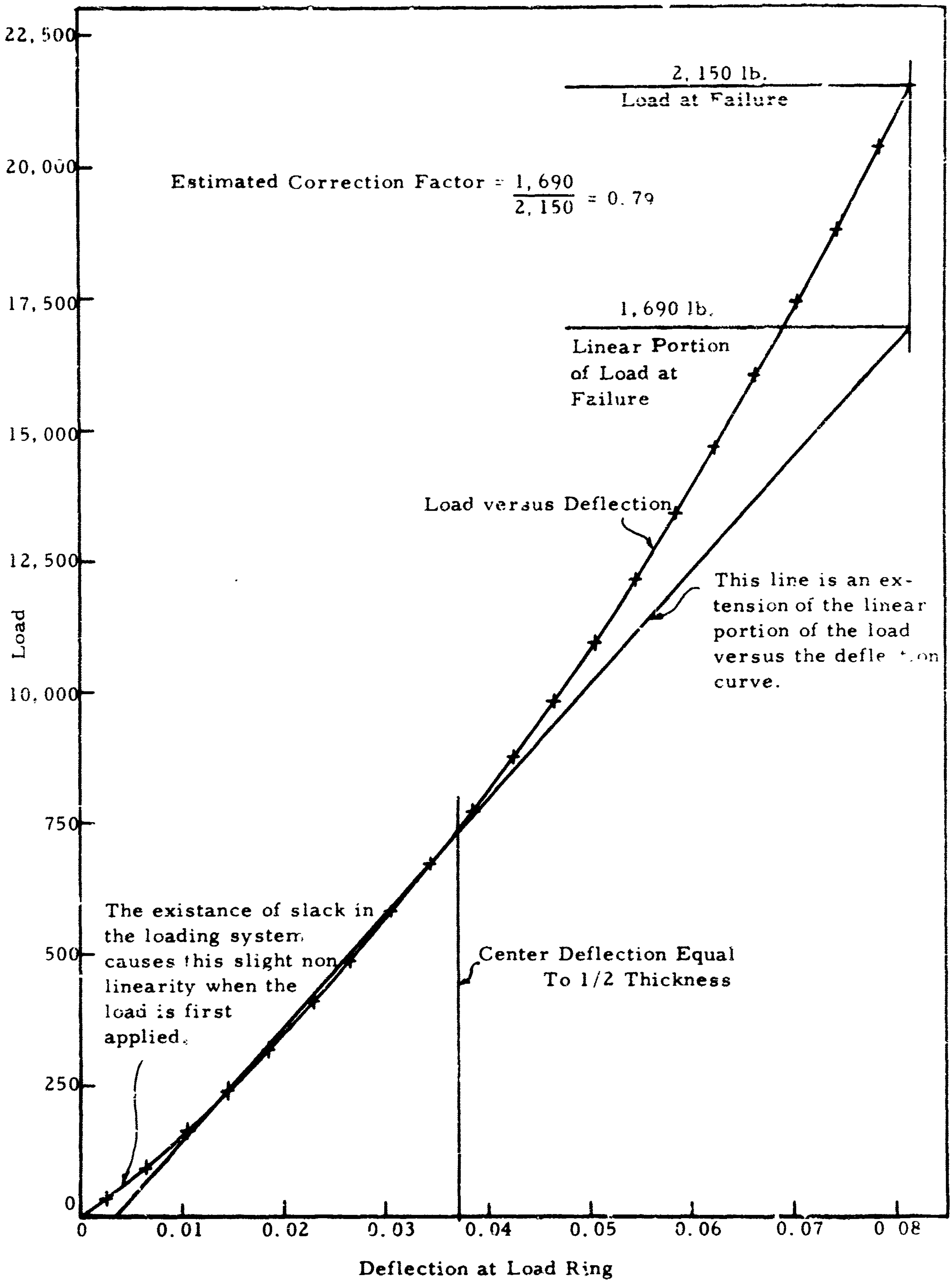


Figure 7 - Graphical Estimation of Correction Factor for Membrane Stresses for Typical Full Tempered Herculite II Sample

APPENDIX II

INDIVIDUAL TESTING RESULTS

The individual results of the destructive testing for each type glass are presented here.

The following symbols are used in this appendix to indicate the location of the fracture origin and the direction of the maximum stress at failure.

Concentric Ring Testing

I - Fracture origin located inside the diameter of the loading ring.

Ir - Fracture origin located at the diameter of the loading ring.

_T O - Fracture origin outside of maximum stress area with maximum stress at failure acting in a tangential direction. Numbers in the blank before the T indicate the distance in inches from the load ring.

_R O - Same meaning as above except maximum stress at failure acting in a radial direction.

_T_° O - Additional information contained in the blank following the T indicates the angle to the tangential direction at which the maximum stress at failure occurred. Other symbols have the same meaning as above.

Or - Fracture origin located over diameter of support ring.

OE - Fracture origin located at edge of sample.

Beam Testing

IC or Ic - Fracture origin located inside the area of maximum stress in the center portion of the sample, i.e., not at an edge.

IE - Fracture origin located inside the area of maximum stress, but at an edge.

_OC - Fracture origin located outside the area of maximum stress away from the edges. Numbers in the blank indicate the distance in inches from the maximum stress area.

_OE - Same as above except fracture origin located at an edge.

Statistical Information

SD - Standard Deviation.

TABLE 7
INDIVIDUAL TESTING RESULTS, FULL TEMPER CHEMCOR
SAMPLE SIZE 4 x 4 x 1/10 IN., TESTING METHOD 1-1/2 AND 3 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 15000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-I Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress With Membrane Stress, psi	Breaking Stress Corrected for Membrane Stress, psi
1	.1010	6509	268.0	46471	7.14	1550	I	1	70400	56300
2	.1041	5472	300.0	52020	9.51	1748	0.08"T O	.95	70900	56700
3	.1043	6224	250.6	43454	6.98	1652	I	1	70300	56300
4	.1030	6425	261.8	45396	7.07	1462	I	1	63800	51100
5	.1044	6493	273.2	47373	7.30	1202	I	1	51100	40900
6	.1006	6594	259.2	44945	6.82	1510	Ir	1	69100	55300
7	.0970	6908	264.6	45882	6.64	1410	I	1	69300	55500
8	.1049	6297	262.6	45535	7.23	1516	I	1	63800	51000
9	.0987	6715	274.4	47581	7.09	972	I	1	46200	37000
10	.1035	6361	270.2	46853	7.37	1620	I	1	70000	56000
11	.1051	6138	269.4	46714	7.61	1690	I	1	70800	56700
12	.1061	5490	305.0	52887	9.63	1742	I	1	71700	57400
13	.1043	6441	274.0	47512	7.38	1702	I	1	72400	58000
14	.1040	6373	244.6	42414	6.66	1466	I	1	62800	50200
15	.0995	6635	259.0	44911	6.77	1240	I	1	58000	46400
16	.1059	5467	301.6	52297	9.57	1318	I	1	54500	43600
17	.0969	6977	237.0	41096	5.89	930	I	1	45900	36700
18	.1060	5180	184.8	32044	6.19	1300	Ir	1	53600	42900
19	.1011	7269	258.6	44841	6.17	1644	I	1	74500	59600
20	.1041	6794	256.0	44390	6.53	1538	I	1	65800	52600
21	.1038	7034	263.6	45708	6.50	1704	I	1	73200	58600
22	.1004	7239	248.6	43107	5.95	1366	I	1	62800	50200
23	.1055	5992	308.2	53442	8.92	1726	I	1	71900	57500
24	.1003	7223	265.8	46090	6.38	1448	I	1	66700	53400
25	.1052	6635	268.8	46610	7.02	1232	I	1	51600	41300
26	.1052	5939	303.6	52644	8.86	1834	I	1	76800	61400
27	.1059	6749	271.2	47026	6.97	1570	I	1	64800	51900
28	.0996	7200	267.0	46298	6.43	1616	I	1	75500	60400
29	.1026	7164	266.6	46228	6.45	1200	I	1	52800	42300
30	.1016	7054	267.4	46367	6.57	1438	I	1	64600	51600
31	.1018	7079	264.6	45882	6.48	1550	I	1	70000	56000
32	.1040	6874	249.4	43246	6.29	1092	I	1	46800	37400
33	.0995	7136	266.4	44194	6.19	1728	I	1	80800	64700
34	.0994	6425	192.6	33397	5.20	1184	I	1	55500	44400
35	.1042	6776	259.2	44945	6.63	1166	I	1	49800	39800
36	.1059	6760	262.2	45465	6.73	1540	I	1	63600	50900
37	.1041	6617	257.8	44703	6.76	1604	I	1	68600	54900
38	.1021	6845	250.8	43489	6.35	1486	I	1	66000	52800
39	.1056	5878	251.4	43593	7.42	1464	I	1	60800	48600
40	.1047	5837	311.4	53997	9.25	1696	I	1	71700	57400
41	.1006	6069	182.4	31628	5.21	996	I	1	45600	36500
42	.1054	5832	304.4	52783	9.05	1662	I	1	69300	55500
43	.1043	6949	265.2	45986	6.62	1464	I	1	62400	49900
44	.0999	7269	264.6	45882	6.31	1386	I	1	64400	51500
45	.1046	6965	254.2	44078	6.33	1676	I	1	71000	56800
46	.1035	5955	317.4	55037	9.24	1564	Ir	1	67700	54100
47	.1057	5764	313.4	54344	9.43	1810	I	1	75100	60100
48	.1043	7041	260.4	45153	6.41	1490	I	1	63400	50700
49	.1021	6826	250.2	43385	6.36	1120	I	1	49700	39800
50	.1003	5864	223.0	38668	6.59	1256	Ir	1	57800	46200
51	.0993	7109	254.6	44148	6.21	1420	Ir	1	66700	53400
		Mean 6530		Mean 45770	Mean 7.07				Mean 63970	Mean 51180
									SD 9030	SD 7230
									High 80800	High 64700
									Low 45600	Low 36500
									Range 35200	Range 28200

TABLE 8

INDIVIDUAL TESTING RESULTS, ANNEALED HERCULITE II

SAMPLE SIZE 4 x 4 x 1/10 IN., TESTING METHOD 1-1/2 AND 3 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - INSTRON, LOADING RATE 15000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.0999	30	175	I	1	8100
2	.1000	28	304	I	1	14100
3	.0994	28	391	I	1	18300
4	.1018	31	334	I	1	14900
5	.1021	30	388	I	1	17200
6	.1014	28	352	I	1	15800
7	.1010	30	363	I	1	16500
8	.1013	28	376	I	1	17000
9	.1010	28	366	I	1	16600
10	.1023	32	366	I	1	11700
11	.1008	32	361	I	1	16500
12	.1052	28	337	I	1	15100
13	.1021	30	341	I	1	15200
14	.1020	28	325	I	1	14500
15	.1021	27	337	I	1	14900
16	.0995	27	364	I	1	17000
17	.0997	27	369	I	1	17200
18	.1003	27	313	Ir	1	14400
19	.1006	31	363	I	1	16600
20	.1024	30	355	I	1	15700
21	.1005	31	326	I	1	14900
22	.1043	28	192	I	1	8200
23	.1050	24	259	I	1	10900
24	.1044	34	275	I	1	11700
25	.1052	34	327	I	1	13700
26	.1058	28	394	I	1	16300
27	.1050	31	299	I	1	12600
28	.1049	34	316	I	1	13300
29	.1046	31	324	I	1	13700
30	.0992	28	222	I	1	10400
31	.1052	34	210	I	1	8800
32	.1008	31	379	I	1	17300
33	.1016	34	348	I	1	15600
34	.1014	38	412	I	1	18600
35	.1003	31	309	I	1	14200

TABLE 8 (CONTINUED)

Sample No.	Average Thickness in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
36	.1001	24	359	I	1	16600
37	.1002	32	339	I	1	15600
38	.1008	27	305	Ir	1	13800
39	.1009	28	366	I	1	16600
40	.1013	27	163	I	1	7300
41	.1011	31	315	I	1	14300
42	.1015	30	259	I	1	11600
43	.1013	27	272	I	1	12300
44	.1016	30	339	I	1	15000
		Mean 30				Mean 14330 SD 2780 High 18600 Low 7300 Range 11300

TABLE 9
INDIVIDUAL TESTING RESULTS, FULL TEMPER HERCULITE II
SAMPLE SIZE 4 x 4 x 1/10 IN., TESTING METHOD 1-1/2 AND 3 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 15000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-I Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi With Membrane Stress	Breaking Stress psi Corrected for Membrane Stress
1	.1009	6975	290.0	54897	7.87	1880	Ir	1	84700	67700
2	.1005	7088	291.2	55124	7.78	1794	Ir	1	82200	65800
3	.1008	6975	289.2	54746	7.85	1810	I	1	82500	66000
4	.1012	6975	281.8	53345	7.65	1746	I	1	78900	63100
5	.1018	6919	294.8	55806	8.07	1798	I	1	80300	64200
6	.1011	6975	306.2	57964	8.31	1618	Ir	1	73300	58600
7	.0998	6919	296.4	56109	8.11	1590	I	1	74000	59200
8	.1008	6975	303.4	57434	8.23	1814	Ir	1	82700	66200
9	.1006	6975	292.4	55351	7.94	1920	Ir	1	87800	70200
10	.1016	6919	294.6	55768	8.06	2160	I	1	96800	77500
11	.1000	7031	293.8	55616	7.91	2000	I	1	92600	74100
12	.0996	7031	295.6	55957	7.96	1756	I	1	82000	65500
13	.1005	6975	308.4	58380	8.37	1780	I	1	81600	65300
14	.1010	6975	296.2	56071	8.04	1852	Ir	1	84000	67200
15	.1008	7031	290.4	54973	7.82	1758	I	1	80100	64100
16	.1004	7031	290.6	55011	7.82	1976	I	1	90900	72700
17	.1019	6975	309.2	58532	8.39	1876	I	1	83600	66900
18	.1019	6919	285.8	54102	7.82	1942	Ir	1	86600	69200
19	.1005	7088	305.4	57812	8.16	1824	I	1	83700	66900
20	.1037	7594	321.2	60803	8.01	2040	I	1	87900	70300
21	.1008	7031	301.8	57131	8.13	1856	I	1	84700	67700
22	.1004	7088	304.0	57547	8.12	2240	I	1	102900	82400
23	.1046	6581	287.2	54367	8.26	1988	Ir	1	84100	67300
24	.1056	6581	306.8	58077	8.82	1920	Ir	1	79600	63700
25	.1052	6581	315.6	59743	9.08	2150	Ir	1	90000	72000
26	.1054	6525	321.2	60803	9.32	2175	I	1	90600	72500
27	.1048	6525	303.8	57509	8.81	2150	I	1	90500	72400
28	.1043	6638	355.4	67277	10.14	1742	Ir	1	74200	59300
29	.1044	6638	300.2	56828	8.56	1844	I	1	78300	62600
30	.0991	7031	340.8	64513	9.18	1708	I	1	80500	64400
31	.0998	6975	288.8	54670	7.84	1602	I	1	74500	59600
32	.1005	6919	297.0	56222	8.13	1802	I	1	82600	66100
33	.1007	6919	289.6	54821	7.92	2020	I	1	92200	73800
34	.1014	6863	288.2	54556	7.95	1482	I	1	66800	53400
35	.0998	6948	285.8	54102	7.79	1780	I	1	82700	66200
36	.1009	6919	293.4	55541	8.03	1912	I	1	87000	69600
37	.1009	6919	302.0	57169	8.26	1932	I	1	87900	70300
38	.1012	6919	307.2	58153	8.40	1776	I	1	80300	64300
39	.1012	6919	295.2	55881	8.08	1838	Ir	1	83100	66500
40	.1018	6863	282.8	53534	7.80	1536	I	1	68700	54900
41	.1018	6863	296.4	56109	8.18	1910	I	1	85200	68200
42	.1013	6919	294.6	55768	8.06	1760	I	1	79400	63500
43	.1015	6863	301.2	57017	8.31	1930	Ir	1	86700	69400
44	.1014	6863	318.2	60235	8.78	1704	I	1	76700	61300
45	.1016	6863	294.8	55806	8.13	2065	I	1	92700	74200
46	.0996	7144	296.4	56109	7.85	2500	Ir	1	116800	93400
47	.1052	7481	313.6	59364	7.94	1950	I	1	81600	65300
48	.1049	7425	312.0	59062	7.95	1898	I	1	79900	63900
49	.1008	7088	317.2	60046	8.47	1814	I	1	82700	66200
50	.1008	7088	289.4	54783	7.73	1720	I	1	78400	62700
51	.1004	6919	311.2	58910	8.51	1654	I	1	75000	60800
		Mean 6950		Mean 56970	Mean 8.21				Mean 83790	Mean 67010
									SD 8170	SD 6540
									High 116800	High 93400
									Low 66800	Low 53400
									Range 50000	Range 40000

TABLE 10

INDIVIDUAL TESTING RESULTS, ANNEALED ALUMINO SILICATE

SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - INSTRON, LOADING RATE 7000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2718	241	1340	I	1	9300
2	.2742	222	1510	I	1	10300
3	.2748	233	1976	I	1	13400
4	.2742	241	1372	I	1	9300
5	.2758	250	1890	I	1	12700
6	.2755	258	1484	Ir	1	10000
7	.2755	239	1780	I	1	12000
8	.2748	233	1476	I	1	10000
9	.2725	250	1168	I	1	8000
10	.2502	184	1370	I	1	11200
11	.2700	233	1770	I	1	12400
12	.2740	250	1332	I	1	9100
13	.2505	184	890	I	1	7200
14	.2548	198	1556	I	1	12300
15	.2532	198	1376	I	1	11000
16	.2592	212	1540	I	1	11700
17	.2550	212	1830	I	1	14400
18	.2605	220	1536	I	1	11600
19	.2748	252	1878	I	1	12700
20	.2720	255	1214	I	1	8400
21	.2682	228	1370	I	1	9700
22	.2720	239	1870	I	1	12900
23	.2498	195	1438	I	1	11800
24	.2635	209	1264	I	1	9300
25	.2520	201	1524	I	1	12300
		Mean				Mean
		225				10920
						SD
						1840
						High
						14400
						Low
						7200
						Range
						7200

TABLE 11
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS.
TESTING MACHINE - INSTRON, LOADING RATE 7000 PSI/MIN.

Sample No.	Average Thickness In.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2746	3750	55.2	9229	2.46	2690	I	1	18200
2	.2740	4249	65.0	10868	2.56	3015	I	1	20500
3	.2743	4242	61.0	10199	2.40	2880	I	1	19400
4	.2739	4561	69.8	11671	2.56	3140	I	1	21400
5	.2762	4041	66.0	11035	2.73	3110	I	1	20800
6	.2712	4409	63.0	10534	2.39	2810	I	1	19500
7	.2755	3988	57.8	9664	2.42	2995	I	1	20200
8	.2724	3858	58.8	9831	2.55	2750	I	1	18900
9	.2724	3845	63.2	10567	2.75	2975	I	1	20500
10	.2747	4253	75.4	12607	2.96	3515	I	1	23800
11	.2704	3570	62.4	10433	2.92	3050	I	1	21300
12	.2592	4062	63.8	10667	2.63	2400	I	1	18300
13	.2586	4336	71.2	11905	2.75	2785	I	1	21300
14	.2823	4292	64.0	10701	2.49	2720	I	1	17400
15	.2763	3988	61.0	10199	2.56	2900	Ir	1	19400
16	.2758	4106	68.2	11403	2.78	2580	Ir	1	17300
17	.2771	3895	60.0	10032	2.58	2715	I	1	18100
18	.2660	3559	55.0	9196	2.58	2115	I	1	15300
19	.2658	3650	56.4	9430	2.58	2675	I	1	19400
20	.2638	3598	57.2	9564	2.66	2580	I	1	19000
21	.2608	3494	52.4	8761	2.51	2395	I	1	18000
22	.2595	3511	53.6	8962	2.55	2350	I	1	17800
		Mean 3970		Mean 10340	Mean 2.61				Mean 19350
									SD 1830
									High 23800
									Low 15300
									Range 8500

TABLE 12
INDIVIDUAL TESTING RESULTS, 3/4 TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 7000 PSI/MIN.

Sample No.	Average Thickness In.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2571	5175	84.0	14045	2.71	2975	I	1	23000
2	.2654	5577	85.8	14346	2.57	3565	Ir	1	25900
3	.2655	5039	73.8	12339	2.45	3250	I	1	23600
4	.2639	5165	79.4	13276	2.57	3415	I	1	25100
5	.2626	5312	89.4	14948	2.81	3375	I	1	25000
6	.2659	5414	82.6	13811	2.55	3575	Ir	1	25800
7	.2715	4958	75.0	12540	2.53	3875	Ir	1	26900
8	.2624	5030	81.0	13543	2.69	3070	I	1	22800
9	.2695	5334	76.2	12741	2.39	3995	I	1	28100
10	.2610	5251	79.6	13309	2.53	3270	I	1	24500
11	.2613	5208	81.4	13610	2.61	3200	I	1	24000
12	.2561	5273	82.2	13744	2.61	3175	I	1	24700
13	.2618	5212	80.8	13510	2.59	2750	I	1	20500
14	.2603	5052	81.0	13543	2.68	3125	I	1	23600
15	.2614	4883	78.0	13042	2.67	3025	Ir	1	22600
16	.2646	5241	76.6	12808	2.44	3515 0.14"T	O	.96	24600
17	.2648	5360	79.4	13276	2.48	3605	I	1	26300
18	.2580	5143	77.8	13008	2.53	2875	I	1	22100
19	.2626	4987	76.4	12774	2.56	3100	I	1	23000
20	.2492	5269	83.6	13978	2.65	3000	I	1	24700
		Mean 5190		Mean 13410	Mean 2.58				Mean 24340
									SD 1780
									High 28100
									Low 20500
									Range 7600

TABLE 13

INDIVIDUAL TESTING RESULTS, FULL TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 7000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2654	7693	115.8	19362	2.52	3665	I	1	26600
2	.2642	7664	115.4	19295	2.52	3800	I	1	27800
3	.2580	7938	126.4	21134	2.66	3900	I	1	29900
4	.2575	7899	131.0	21903	2.77	3995	I	1	30800
5	.2691	7795	121.6	20332	2.61	4650	I	1	32800
6	.2582	7291	113.6	18994	2.61	3740	I	1	28700
7	.2622	7730	135.8	22706	2.94	5020	I	1	37300
8	.2634	7736	126.6	21168	2.74	4300	I	1	31700
9	.2588	7693	126.4	21134	2.75	4000	Ir	1	30500
10	.2539	7747	121.8	20365	2.63	4125	Ir	1	31500
11	.2592	7562	122.0	20398	2.70	3875	I	1	29500
12	.2584	7730	121.0	20231	2.62	3890	I	1	29800
13	.2610	7573	116.6	19496	2.57	3770	I	1	28300
14	.2619	7569	127.8	21368	2.82	4170	I	1	31100
15	.2611	7812	136.8	22873	2.93	4325	I	1	32400
16	.2584	8062	133.6	22338	2.77	3935	I	1	30100
17	.2530	7990	141.6	23676	2.96	3950	I	1	31500
18	.2567	7721	129.8	21703	2.81	3800	I	1	29500
19	.2543	7925	135.2	22605	2.85	4160	I	1	32900
20	.2619	7758	133.4	22304	2.87	4150	I	1	30900
21	.2657	7812	124.0	20733	2.65	4110	I	1	29700
		Mean 7750		Mean 21150	Mean 2.73				Mean 30630
									SD 2220
									High 37300
									Low 26600
									Range 10700

TABLE 14
INDIVIDUAL TESTING RESULTS, ANNEALED ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5362	326	6570	I	1	11700
2	.5365	353	5900	I	1	10500
3	.5360	320	5750	I	1	10200
4	.5358	336	6900	I	1	12300
5	.5362	326	6310	I	1	11200
6	.5400	350	6580	I	1	11500
7	.5425	347	6630	I	1	11500
8	.5422	304	5580	I	1	9700
9	.5460	358	5260	I	1	9000
10	.5550	353	6950	I	1	11500
11	.5510	358	7600	I	1	12800
12	.5448	358	6620	I	1	11400
13	.5478	353	5100	I	1	8700
14	.5562	369	6890	I	1	11400
15	.5520	347	7150	Ir	1	12000
16	.5442	353	5410	I	1	9300
17	.5468	347	5180	I	1	8900
18	.5528	347	7000	I	1	11700
19	.5615	380	8450	I	1	13700
20	.5578	342	6500	I	1	10700
21	.5472	369	1420	I	1	11000
22	.5495	350	6340	I	1	10700
		Mean 343				Mean 10970
						SD 1280
						High 13700
						Low 8700
						Range 5000

TABLE 16

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER ALUMINO SILICATE

SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,

TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5527	6043	114.0	19061	3.15	16500	I	1	27600
2	.5514	6028	118.0	19730	3.27	18900	I	1	31800
3	.5491	6217	114.0	19061	3.07	16350	I	1	27700
4	.5438	6143	122.4	20465	3.33	18225	I	1	31500
5	.5439	6137	114.4	19128	3.12	16695	I	1	28800
6	.5324	5464	109.4	18292	3.35	13920	I	1	25100
7	.5381	5625	106.4	17790	3.16	13500	I	1	23800
8	.5329	5529	109.4	18292	3.31	12345	I	1	22200
9	.5334	5638	108.6	18158	3.22	12530	I	1	22500
10	.5373	5312	103.2	17255	3.25	15675	I	1	27700
11	.5344	5664	107.0	17890	3.16	14280	I	1	25600
12	.5357	5408	108.0	18058	3.34	13500	Ir	1	24000
13	.5343	5403	100.2	16753	3.10	18300	Ir	1	32800
14	.5329	5382	98.8	16519	3.07	14340	I	1	25800
15	.5323	5334	102.0	17054	3.20	14400	I	1	26000
16	.5392	5334	105.0	17556	3.29	14745	Ir	1	25900
17	.5406	5312	93.0	15550	2.93	12675	0.20"T O	.94	20800
18	.5366	5204	95.0	15884	3.05	11985	I	1	21300
19	.5385	5143	90.4	15115	2.94	13170	I	1	23200
20	.5404	5056	94.0	15717	3.11	11895	I	1	20800
21	.5364	5052	85.2	14245	2.82	13845	I	1	24600
		Mean 5540		Mean 17500	Mean 3.15				Mean 25690
									SD 3500
									High 32800
									Low 20800
									Range 12000

TABLE 15
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5308	3570	61.6	10300	2.89	10950	I	1	19900
2	.5306	3474	70.0	11704	3.37	11430	0.25"T O	.92	19100
3	.5424		67.8	11336		10500	I	1	18200
4	.5356	3472	63.2	10567	3.04	14220	I	1	25300
5	.5377	3537	67.6	11303	3.20	10575	I	1	18700
6	.5325	3476	64.6	10801	3.11	13050	I	1	23500
7	.5324	3515	60.8	10166	2.89	14265	0.80"T O	.73	18700
8	.5596	3511	68.0	11370	3.24	13530	I	1	22100
9	.5551	3620	66.8	11169	3.09	12720	I	1	21100
10	.5563	3505	70.0	11704	3.34	14190	I	1	23400
11	.5520	3526	68.4	11436	3.24	12165	I	1	20400
12	.5474	3620	70.6	11801	3.26	12390	I	1	21100
13	.5493	3613	71.2	11905	3.30	15000	Ir	1	25400
14	.5304	3407	65.0	10868	3.19	11925	I	1	21700
15	.5328	3434	61.6	10300	3.00	11220	I	1	20200
16	.5316	3424	62.2	10400	3.04	10410	I	1	18800
17	.5317	3277	60.0	10032	3.06	11745	I	1	21200
18	.5302	3559	64.2	10734	3.02	10425	0.15"T O	.96	18100
19	.5306	3157	63.0	10534	3.34	10695	I	1	19400
20	.5314	3446	66.0	10032	2.91	11824	I	1	21400
21	.5340	3476	64.8	10835	3.12	10545	I	1	18900
		Mean		Mean	Mean				Mean
		3480		10920	3.14				20790
									SD
									2180
									High
									25400
									Low
									18100
									Range
									7300

TABLE 16
INDIVIDUAL TESTING RESULTS, 3/4 TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5527	6043	114.0	19061	3.15	16500	I	1	27600
2	.5514	6028	118.0	19730	3.27	18900	I	1	31800
3	.5491	6217	114.0	19061	3.07	16350	I	1	27700
4	.5438	6143	122.4	20465	3.33	18225	I	1	31500
5	.5439	6137	114.4	19128	3.12	16695	I	1	28800
6	.5324	5464	109.4	18292	3.35	13920	I	1	25100
7	.5381	5625	106.4	17790	3.16	13500	I	1	23800
8	.5329	5529	109.4	18292	3.31	12345	I	1	22200
9	.5334	5638	108.6	18158	3.22	12530	I	1	22500
10	.5373	5312	103.2	17255	3.25	15675	I	1	27700
11	.5344	5664	107.0	17890	3.16	14280	I	1	25600
12	.5357	5408	108.0	18058	3.34	13500	Ir	1	24000
13	.5343	5403	100.2	16753	3.10	18300	Ir	1	32800
14	.5329	5382	98.8	16519	3.07	14340	I	1	25800
15	.5323	5334	102.0	17054	3.20	14400	I	1	26000
16	.5392	5334	105.0	17556	3.29	14745	Ir	1	25900
17	.5406	5312	93.0	15550	2.93	12675	0.20"T O	.94	20800
18	.5366	5204	95.0	15884	3.05	11985	I	1	21300
19	.5385	5143	90.4	15115	2.94	13170	I	1	23200
20	.5404	5056	94.0	15717	3.11	11895	I	1	20800
21	.5364	5052	85.2	14245	2.82	13845	I	1	24600
		Mean 5540		Mean 17500	Mean 3.15				Mean 25690
									SD 3500
									High 32800
									Low 20800
									Range 12000

TABLE 17

INDIVIDUAL TESTING RESULTS, FULL TEMPER ALUMINO SILICATE
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average MDSR-II Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5355	7048	132.0	22070	3.13	19270	I	1	34300
2	.5459	6922	130.4	21803	3.15	16410	I	1	28100
3	.5544	6977	129.8	21703	3.11	16180	I	1	26900
4	.5432	7031	140.8	23542	3.35	14180	I	1	24600
5	.5377		135.6	22672		14280	I	1	25200
6	.5392	7578	140.2	23441	3.09	17620	I	1	31000
7	.5408	7751	133.8	22371	2.89	13310	I	1	23300
8	.5347	7599	137.4	22973	3.02	17350	I	1	31000
9	.5351		140.2	23441		16675	I	1	28900
10	.5345	7504	142.2	23776	3.17	16710	I	1	29900
11	.5341	7606	138.0	23074	3.03	15660	I	1	28100
12	.5379	7721	138.2	23107	2.99	16550	I	1	29200
13	.5293	7638	144.6	24177	3.17	17630	I	1	32200
14	.5344	6679	131.8	22037	3.30	17590	I	1	31500
15	.5299	7400	137.6	23007	3.11	17200	I	1	31300
16	.5348	7556	144.6	24177	3.20	17760	I	1	31700
17	.5300	7400	145.4	24311	3.29	18380	Ir	1	33400
18	.5406	7465	136.6	22840	3.06	21430	I	1	37500
19	.5357	7374	134.8	22539	3.06	18430	I	1	32800
20	.5405	7465	142.4	23809	3.19	19060	Ir	1	33300
21	.5441	7845	141.8	23709	3.02	17420	Ir	1	30100
		Mean 7400		Mean 23080	Mean 3.12				Mean 30250
									SD 3410
									High 37500
									Low 23300
									Range 14200

TABLE 18
INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 3/16 IN., TESTING METHOD 3 AND 6IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Breaking Load lb.	Fracture Origin		Fracture Origin Factor	Breaking Stress psi.
1	.1855	715		Ir	1	10600
2	.1850	950		Or	1	6600
3	.1828	880		I	1	13500
4	.1840	659	0.42"T	O	.86	8600
5	.1838	793		I	1	12000
6	.1918	1138		I	1	15800
7	.1920	940		I	1	13000
8	.1940	589	0.66"T	O	.78	6200
9	.1935	928		I	1	12700
10	.1930	740		I	1	10100
11	.1940	739	0.28"T-10°	O	.95	9500
12	.1900	510		I	1	7200
13	.1918	683		I	1	9500
14	.1930	677	0.06"R	O	.93	8600
15	.1940	794		Ir	1	10800
16	.1948	892		I	1	12000
17	.1922	797		I	1	11000
18	.1918	530	0.18"T-10°	O	.92	6800
19	.1928	730		I	1	10000
20	.1928	684		I	1	9400
21	.1940	782	0.2"T-8°	O	.93	9900
22	.1898	450		I	1	6400
23	.1908	700		I	1	9800
24	.1915	654		I	1	9100
25	.1918	700		I	1	9700
26	.1925	870		I	1	12000
27	.1915	690		I	1	9600
						Mean 10020
						SD 2310
						High 15800
						Low 6200
						Range 9600

TABLE 19

INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667

SAMPLE SIZE 6-1/8 x 6-1/8 x 3/16 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average DSR Reading	Surface Compression psi.	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi.
1	.1828	145.8	8774	1277	I	1	19500
2	.1928	134.5	8094	1840	Ir	1	25300
3	.1815	145.4	8750	1233	I	1	19100
4	.1833	158.8	9557	1287	I	1	19600
5	.1823	141.8	8534	1347	I	1	20700
6	.1915	156.4	9412	1260	Ir	1	17600
7	.1915	155.4	9352	1513	I	1	21100
8	.1923	138.3	8317	1528	Ir	1	21100
9	.1825	159.3	9581	1008	I	1	15500
10	.1825	136.2	8197	1293	I	1	19800
11	.1820	139.0	8365	1200	I	1	18500
12	.1923	149.4	8991	1735	I	1	24000
13	.1893	170.3	10243	1147	0.12"T O	.96	15700
14	.1915	131.4	7908	1092	0.31"T O	.90	13700
15	.1913	142.8	8594	1040	0.25"T O	.92	14400
16	.1920	159.5	9599	1250	I	1	17300
17	.1848	152.6	9183	1135	I	1	17000
18	.1928	113.8	6848	1096	I	1	15100
19	.1845	123.5	7432	1423	I	1	21400
20	.1845	144.5	8696	1100	0.25"T O	.92	15200
21	.1895	142.0	8546	1304	0.56"T O	.82	15200
22	.1843	152.2	9159	972	I	1	14600
23	.1838	131.5	7914	1093	I	1	16500
24	.1838	144.4	8690	816	I	1	12300
25	.1918	142.8	8594	1533	I	1	21300
26	.1925	123.8	7450	1269	Ir	1	17500
27	.1915	151.8	9135	1217	I	1	17000
28	.1895	150.2	9039	1224	I	1	17400
			Mean				Mean
			8680				17980
							SD
							3130
							High
							25300
							Low
							12300
							Range
							[illegible]

TABLE 20
INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 3/16 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average DSR Reading	Surface Compression psi.	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress with Membrane Stress psi.	Breaking Stress Corrected for Membrane Stress psi.
1	.1865	182.5	10983	1959	0.12"T C	.96	27600	24900
2	.1845	171.0	10291	1718	I	1	25800	23200
3	.1868	163.0	9809	1730	Ir	1	25300	22800
4	.1845	183.8	11061	1615	I	1	24200	21800
5	.1840	183.8	11061	1739	I	1	26200	23600
6	.1858	189.8	11422	1580	I	1	23400	21100
7	.1858	201.8	12144	1560	Ir	1	23100	20800
8	.1835	189.8	11422	1676	I	1	25400	22900
9	.1845	202.5	12186	2057	Ir	1	30900	27800
10	.1858	177.0	10652	1341	I	1	19900	17900
11	.1895	182.6	10989	1283	Ir	1	18200	16400
12	.1850	206.8	12445	1914	I	1	28600	25700
13	.1848	184.8	11121	1374	I	1	20600	18500
14	.1888	188.8	11362	1890	I	1	27100	24400
15	.1860	200.0	12036	1536	I	1	22700	20400
16	.1878	193.0	11614	1380	I	1	20000	18000
17	.1860	194.5	11705	1599	I	1	23700	21300
18	.1860	175.2	10544	1716	I	1	25300	22800
19	.1885	165.5	9960	1881	0.12"T O	.96	26000	23400
20	.1828	209.8	12626	1806	0.12"T O	.96	26600	23900
21	.1865	188.5	11344	1698	I	1	25000	22500
22	.1860	192.2	11567	1971	0.38"T O	.88	25700	23100
23	.1880	169.8	10219	1533	I	1	22200	20000
24	.1885	173.8	10459	1799	I	1	25900	23300
25	.1860	166.5	10020	1536	I	1	22700	20400
			Mean 11160				Mean 24490	Mean 22040
							SD 2910	SD 2620
							High 30900	High 27800
							Low 18200	Low 16400
							Range 12700	Range 11400

TABLE 21
INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 3/16 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi.	Average DSR Reading	Surface Compression psi.	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress with Membrane Stress, psi.	Breaking Stress Corrected for Membrane Stress, psi.
1	.1888		283.0	17031		2530	I	1	36200	32600
2	.1993		270.5	16379		2310	I	1	33300	30000
3	.1840		259.5	15617		2150	I	1	32400	29200
4	.1835		243.8	14672		1680	I	1	25600	23000
5	.1935		265.8	15996		1810	I	1	27400	24700
6	.1840		229.5	13811		2015	I	1	30400	27400
7	.1840		243.5	14654		1445	I	1	21800	19600
8	.1903		238.5	14353		2150	I	1	30300	27300
9	.1845		270.0	16249		2090	I	1	31300	28200
10	.1878		244.3	14702		2450	I	1	35500	32000
11	.1940	6561	244.0	14684	2.24	1830	I	1	27700	24900
12	.1838	6666	249.5	15015	2.25	1915	I	1	29000	26100
13	.1838	6635	238.8	14371	2.17	1625	I	1	24600	22100
14	.1860	6630	245.5	14774	2.23	1790	I	1	26400	23800
15	.1865	6859	237.6	14299	2.08	1820	I	1	26800	24100
16	.1829		247.8	14913		2310	Ir	1	32800	29500
17	.1845	6960	243.8	14672	2.11	1750	I	1	26200	23600
18	.1913	7016	263.8	15875	2.26	1930	I	1	27000	24300
19	.1908	7317	256.2	15418	2.11	2240	Ir	1	31400	28300
20	.1905	7006	275.2	16562	2.36	2015	I	1	28300	25500
21	.1920	6986	278.2	16742	2.40	2165	I	1	30000	27000
22	.1905	7109	249.0	14985	2.11	2165	I	1	30400	27400
23	.1883	7000	277.0	16670	2.38	2080	I	1	30000	27000
24	.1900	6777	242.5	14594	2.15	2380	I	1	33700	30300
25	.1898	6811	253.5	15256	2.24	2070	I	1	29300	26400
26	.1896	6869	275.5	16580	2.40	2170	I	1	31200	28100
27	.1870	6757	224.5	13510	2.00	1500	I	1	21900	19700
		Mean		Mean	Mean				Mean	Mean
		6870		15270	2.22				29300	26370
									SD	SD
									3640	3280
									High	High
									36200	32600
									Low	Low
									21800	19600
									Range	Range
									14400	13000

TABLE 22

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 6000 PSI/MIN.

Sample No.	Average Thickness in.	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi.
1	.2445	1232	I	1	10500
2	.2448	984	0.11"T O	.93	7800
3	.2435	1460	I	1	12600
4	.2442	1376	0.13"T O	.94	11100
5	.2445	1229	I	1	8800
6	.2428	1006	I	1	8700
7	.2428	1182	I	1	10200
8	.2428	1214	I	1	10500
9	.2425	1026	I	1	8900
10	.2432	426	I	1	3700
11	.2442	1440	0.12"T O	.96	11800
12	.2440	1268	Ir	1	10900
13	.2438	972	Ir	1	8400
14	.2408	1210	I	1	10700
15	.2410	600	Ir	1	5300
16	.2408	626	I	1	5500
17	.2410	934	Ir	1	8200
18	.2395	1270	I	1	11300
19	.2405	1150	I	1	10200
20	.2398	830	I	1	7400
21	.2408	1C74	I	1	9500
22	.2400	936	I	1	8300
23	.2408	1104	I	1	9700
24	.2405	1190	I	1	10500
25	.2410	1120	I	1	9800
26	.2412	1152	Ir	1	10100
27	.2412	924	I	1	8100
28	.2432	1270	I	1	11000

Mean
9270
SD
2080
High
12600
Low
3700
Range
8900

TABLE 23
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 6000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi.	Average DSh Reading	Surface Compression psi.	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi.
1	.2410	3995	154.6	9304	2.33	2560	I	1	22500
2	.2240	3092	177.3	10670	2.74	2425	I	1	24700
3	.2410	4068	160.3	9647	2.37	2660	0.13"h O	.83	19400
4	.2415	3855	152.0	9147	2.37	2245	I	1	19700
5	.2413	3951	199.0	11976	3.03	2930	I	1	25700
6	.2418	4338	172.3	10369	2.39	2665	I	1	23300
7	.2388	3965	155.8	9376	2.36	2570	I	1	23000
8	.2373	3946	154.5	9298	2.36	2480	I	1	22500
9	.2408	4109	160.2	9641	2.35	2800	I	1	24700
10	.2415	4356	161.4	9713	2.23	2335	I	1	20500
11	.2243	3946	155.8	9376	2.38	2425	Ir	1	24600
12	.2370	4175	157.8	9496	2.27	2650	Ir	1	24100
13	.2415	3818	134.4	8088	2.12	2380	I	1	20900
14	.2368	4063	166.2	10002	2.46	2120	I	1	19300
15	.2393	4340	179.0	10772	2.48	2210	I	1	19700
16	.2365	4143	143.5	8636	2.08	2780	0.38"T 34° O	.79	20100
17	.2370	4098	159.5	9599	2.34	2040	I	1	18600
18	.2390	4247	159.8	9617	2.26	2780	0.38"F O	.64	15900
19	.2415	4255	174.8	10519	2.47	2790	I	1	24400
20	.2418	4103	175.8	10580	2.58	2810	I	1	24600
21	.2403	3845	149.2	8979	2.36	2400	I	1	21200
22	.2390	4020	144.8	8714	2.17	2600	I	1	23300
23	.2410	3906	160.0	9629	2.47	2710	I	1	23800
24	.2368	3983	191.5	11524	2.89	2050	I	1	18700
25	.2395	4194	173.3	10429	2.49	2725	I	1	24300
		Mean		Mean	Mean				Mean
		4060		9800	2.41				21980
									SD
									2560
									High
									25700
									Low
									15900
									Range
									9800

TABLE 24

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667

SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - INSTRON, LOADING RATE 6000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi.	Average DSR Reading	Surface Compression psi.	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi.
1	.2378	6401	272.3	16381	2.56	3545	I	1	32000
2	.2378	6401	242.5	14594	2.28	2950	I	1	26700
3	.2370	6200	251.5	15135	2.44	3535	I	1	32200
4	.2358	6347	278.3	16748	2.64	3250	Ir	1	29900
5	.2383	6656	262.8	15815	2.38	3270	Ir	1	29400
6	.2370	6665	264.3	15900	2.38	3060	I	1	27800
7	.2375	6475	282.3	16983	2.62	3355	I	1	30400
8	.2370	5921	214.0	12879	2.18	3080	I	1	28000
9	.2365	6622	281.3	16923	2.56	3415	I	1	31200
10	.2398	6686	251.8	15153	2.27	3760	I	1	33400
11	.2375	6209	259.3	15599	2.51	3290	I	1	29800
12	.2370	6812	280.0	16850	2.47	3330	I	1	30300
13	.2375	6467	253.3	15244	2.36	3110	I	1	28200
14	.2415	6492	260.0	15647	2.41	3235	I	1	28300
15	.2373	6486	248.4	14949	2.30	3335	I	1	30300
16	.2418	6399	273.0	16429	2.57	3645	I	1	31900
17	.2378	6528	255.0	15346	2.35	3310	I	1	29900
18	.2363	6643	274.0	16489	2.48	2965	I	1	27100
19	.2370	6492	282.5	17001	2.62	3150	I	1	28700
20	.2363	6200	256.5	15436	2.49	3660	I	1	33500
21	.2370	6505	275.0	16550	2.54	3485	I	1	31700
22	.2370	6643	269.4	16212	2.44	3025	Ir	1	27500
23	.2368	6599	275.3	16568	2.51	3110	I	1	28300
24	.2370	6482	271.3	16321	2.52	3765	I	1	34300
25	.2415	6145	246.8	14852	2.42	2500	0.06"R O	.92	20200
26	.2390	5693	287.0	17272	3.03	2505	I	1	22410
		Mean 6430		Mean 15900	Mean 2.47				Mean 29360
									SD 315C
									High 34300
									Low 20200
									Range 14100

TABLE 25

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667

SAMPLE SIZE 6-1/8 x 6-1/8 x 1/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - INSTRON, LOADING RATE 6000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2372	7387	324.2	19510	2.64	3700	I	1	33600
2	.2368	7404	285.0	17151	2.32	3450	I	1	31400
3	.2358	7116	285.0	17151	2.41	3695	I	1	34000
4	.2368	7432	284.5	17121	2.30	3930	I	1	26700
5	.2370	7144	273.5	16459	2.30	3330	I	1	30300
6	.2372	7082	299.8	18042	2.54	3840	I	1	34900
7	.2418	7208	286.5	17242	2.39	3380	I	1	29500
8	.2370	7323	286.8	17260	2.36	3660	I	1	33300
9	.2375	6467	248.8	14973	2.32	3060	I	1	27700
10	.2400	7104	281.0	16911	2.38	3575	I	1	31700
11	.2398	7146	285.0	17151	2.40	3815	0.1"R O	.88	29800
12	.2408	7101	272.0	16369	2.31	3460	I	1	30500
13	.2380	7238	291.2	17524	2.42	3505	I	1	31600
14	.2398	7138	300.0	18054	2.53	3940	I	1	35000
15	.2370	7157	286.2	17224	2.41	3360	I	1	30600
16	.2375	6748	272.0	16369	2.43	3480	I	1	31500
17	.2372	7182	277.2	16682	2.32	3285	I	1	29800
18	.2398	7261	286.2	17224	2.37	3250	I	1	28900
19	.2408	7155	282.5	17001	2.38	3530	I	1	31100
20	.2375	6690	297.2	17885	2.67	3440	I	1	31200
21	.2370	7148	288.8	17380	2.43	3380	0.2"T O	.94	28900
22	.2375	7167	308.5	18566	2.59	3080	I	1	27900
23	.2372	7195	301.0	18114	2.52	3490	I	1	31700
24	.2370	7579	284.0	17091	2.26	3630	Ir	1	33000
25	.2372	7310	297.8	17922	2.45	2740	I	1	24900
		Mean 7160		Mean 17300	Mean 2.42				Mean 30780
									SD 2480
									High 35000
									Low 24900
									Range 10100

TABLE 26
INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi	Breaking Stress - psi Excluding Edge Breaks
1	.4822	6290	I	1	13800	13800
2	.4835	4220	I	1	9200	9200
3	.4840	5690	I	1	12400	12400
4	.4822	6420	OE	.50	7100	
5	.4825	4900	OE	.50	5400	
6	.4830	5480	Or	.50	6000	
7	.4840	5130	0.36"T O	.88	9800	9800
8	.4838	5170	OE	.50	5600	
9	.4830	5620	Or	.50	6200	
10	.4855	5520	Or	.50	6000	
11	.4810	2620	0.2"T 39° O	.87	5000	5000
12	.4812	4750	I	1	10500	10500
13	.4820	5700	Or	.50	6300	
14	.4810	5700	I	1	12600	12600
15	.4855	5000	OE	.50	5400	
16	.4862	6080	Or	.50	6600	
17	.4860	5400	I	1	11700	11700
18	.4842	5610	I	1	12200	12200
19	.4812	5200	OE	.50	5700	
20	.4835	4460	OE	.50	4900	
21	.4912	6590	Ir	1	14000	14000
22	.4888	5850	Or	.50	5300	
23	.4885	5030	OE	.50	5400	
24	.4865	4360	OE	.50	4700	
25	.4955	4060	OE	.50	4200	
26	.4915	4900	Ir	1	10400	10400
27	.4905	4280	I	1	9100	9100
28	.4922	5060	Or	.50	5300	
29	.4935	4400	I	1	9200	9200
				Mean	7930	10760
				SD	13090	2430
				High	14000	14000
				Low	4200	5000
				Range	9800	9000

TABLE 27
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4883	4074	145.0	8726	2.14	9885	I	1	21200
2	.4940	4210	140.0	8425	2.00	10000	I	1	20900
3	.4890	4332	159.8	9617	2.22	13380	I	1	28600
4	.4910	4391	153.0	9208	2.10	14730	1.35"T O	.55	17200
5	.4890	4159	117.0	7041	1.69	9810	0.65"T O	.82	17200
6	.4888	4255	138.3	8323	1.96	9810	I	1	21000
7	.4890	4308	156.3	9406	2.18	13470	0.25"T O	.92	26500
8	.4928	4721	157.5	9478	2.01	11400	I	1	24000
9	.4925	4700	218.0	13119	2.79	11340	I	1	23900
10	.4910	4169	142.0	8546	2.05	11070	I	1	23500
11	.4925	4052	152.3	9165	2.26	13110	I	1	27600
12	.4890	4169	153.5	9238	2.22	11820	I	1	25300
13	.4968	4212	153.8	9256	2.20	9330	I	1	19300
14	.4885	4361	158.8	9557	2.19	10680	I	1	22900
15	.4875	4265	136.8	8233	1.93	13335	I	1	28700
16	.4948	4361	166.0	9990	2.29	10785	I	1	22500
17	.4975	4338	131.5	7914	1.82	8730	0.35"T O	.89	16000
18	.4933	4313	169.5	10201	2.37	14370	I	1	30200
19	.4970	4249	153.5	9238	2.17	9030	I	1	18700
20	.4920	4414	167.3	10068	2.28	15570	I	1	32900
21	.4890	4370	145.0	8726	2.00	9225	I	1	19700
22	.4895	4308	149.3	8985	2.09	10650	I	1	22700
23	.4920	4367	151.8	9135	2.09	12000	Ir	1	25300
24	.4875	4414	158.5	9539	2.16	12750	I	1	27400
25	.4928	4233	163.0	9809	2.32	10635	I	1	22400
		Mean		Mean	Mean				Mean
		4330		9240	2.14				23420
									SD
									4310
									High
									32900
									Low
									16000
									Range
									16900

TABLE 28

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4928	5032	212.8	12806	2.54	13820	I	1	29100
2	.4900	5091	223.0	13420	2.64	13550	I	1	28800
3	.4885	5096	206.8	12445	2.44	12100	I	1	25900
4	.4938	5085	216.5	13029	2.56	14020	Ir	1	29400
5	.4883	5083	217.8	13107	2.58	11980	0.10"T O	.97	24900
6	.4885	5080	213.0	12818	2.52	15630	I	1	33500
7	.4885	5099	186.5	11224	2.20	12890	I	1	27600
8	.4895	5048	207.8	12505	2.48	14420	I	1	30800
9	.4878	5112	195.5	11765	2.30	11280	I	1	24200
10	.4895	5117	210.5	12668	2.48	12100	0.12"T O	.96	24800
11	.4915	5187	216.8	13047	2.52	10750	I	1	22700
12	.4913	5064	221.5	13330	2.63	11550	I	1	24500
13	.4883	5053	191.8	11543	2.28	13400	I	1	28700
14	.4875	5080	191.5	11524	2.27	8810	I	1	18900
15	.4898	5112	200.0	12036	2.35	10490	I	1	22300
16	.4900	5165	210.3	12656	2.45	13800	I	1	29400
17	.4920	5192	221.5	13330	2.57	12160	I	1	25700
18	.4905	5016	206.0	12397	2.47	11700	0.04"T O	.99	24600
19	.4913	5122	211.8	12746	2.49	11820	I	1	25000
20	.4880	4952	214.3	12897	2.60	14100	I	1	30300
21	.4943	4707	208.3	12529	2.66	13920	I	1	29100
22	.4885	5219	206.3	12409	2.38	11550	I	1	24700
23	.4903	5123	223.0	13420	2.62	14130	I	1	30000
24	.4885	5181	178.0	10712	2.07	14760	I	1	31600
25	.4938	5136	210.3	12656	2.46	12780	I	1	26800
26	.4885	5064	203.8	12265	2.42	12150	I	1	26000
27	.4933	5184	222.8	13408	2.59	15240	I	1	32000
		Mean 5090		Mean 12540	Mean 2.47			Mean	27090
								SD	3380
								High	33500
								Low	18900
								Range	14600

TABLE 29

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667

SAMPLE SIZE 6-1/8 x 6-1/8 x 1/2 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi	Breaking Stress - psi Excluding Edge Breaks
1	.4965	7796	285.5	17181	2.20	11980	I	1	24800	24800
2	.4973	7700	312.3	18794	2.44	12860	I	1	26600	26600
3	.4938	7977	300.0	18054	2.26	12860	I	1	27000	27000
4	.4878	8035	294.3	17711	2.20	15280	OE	.50	16400	
5	.4950	8003	256.0	15406	1.93	14340	I	1	29900	29900
6	.4940	8174	296.8	17861	2.19	16840	I	1	35300	35300
7	.4928	7799	300.0	18054	2.31	12190	OE	.50	12800	
8	.4905	7908	321.0	19318	2.44	15860	I	1	33700	33700
9	.4943	7876	329.0	19799	2.51	14290	I	1	29900	29900
10	.4943	7604	323.8	19486	2.56	13580	OE	.50	14200	
11	.4888	8051	325.3	19577	2.43	15780	0.13"T O	.96	32400	32400
12	.4923	7615	296.3	17831	2.34	13060	I	1	27500	27500
13	.4905	7721	328.5	19769	2.56	15380	I	1	32700	32700
14	.4878	8150	306.3	18433	2.26	15410	I	1	33100	33100
15	.4925	8222	251.3	15123	1.84	16160	I	1	34000	34000
16	.4880	7948	288.3	17350	2.18	12280	I	1	26400	26400
17	.4865	7953	325.3	19577	2.46	18470	I	1	39900	39900
18	.4905	7897	321.8	19366	2.45	18920	I	1	40200	40200
19	.4865	7788	283.3	17049	2.19	12160	0.17"T O	.95	24900	24900
20	.4883	8041	325.3	19577	2.43	17540	I	1	37600	37600
21	.4915	7844	328.5	19769	2.52	16490	I	1	34900	34900
22	.4955	7769	317.5	19107	2.46	17440	I	1	36300	36300
23	.4920	7551	340.0	20461	2.71	16770	I	1	35400	35400
24	.4933	7689	271.3	16327	2.12	14540	I	1	30500	30500
25	.4903	7349	282.8	17019	2.32	13800	0.14"T O	.96	28200	28200
26	.4918	7673	264.8	15936	2.08	16260	0.10"T O	.97	33300	33300
		Mean		Mean	Mean				Mean	Mean
		7850		18980	2.32				29920	31930
									SD	SD
									7130	4540
									High	High
									40200	40200
									Low	Low
									12800	24800
									Range	Range
									27400	15400

TABLE 30

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 6-1/8 x 6-1/8 x 3/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi	Breaking Stress - psi Excluding Edge Breaks
1	.7390	9750	OE	.50	4600	
2	.7412	8250	I	1	7700	7700
3	.7410	6600	OE	.50	3100	
4	.7362	14700	0.7"T O	.76	10500	10500
5	.7368	12620	OE	.50	5900	
6	.7352	15920	0.32"T O	.90	13500	13500
7	.7365	19320	I	1	18200	18200
8	.7355	11560	0.58"T O	.80	8700	8700
9	.7355	7820	OE	.50	3700	
10	.7382	13220	OE	.50	6200	
11	.7352	5920	OE	.50	2800	
12	.7358	16400	0.8"T O	.73	11300	11300
13	.7350	6080	OE	.50	2900	
14	.7412	7000	1.4"T O	.53	3500	3500
15	.7388	15420	Or	.50	7200	
16	.7388	10580	1.38"T O	.54	5300	5300
17	.7402	10000	Or	.50	4700	
18	.7418	10880	1.38"T O	.54	5500	5500
19	.7378	14360	I	1	13500	13500
20	.7372	14840	Or	.50	7000	
21	.7360	13000	0.6"T O	.80	9800	9800
22	.7378	9720	0.55"T O	.82	7500	7500
					Mean	Mean
					7410	9580
					SD	SD
					4020	4150
					High	High
					18200	18200
					Low	Low
					2800	3500
					Range	Range
					15400	14700

TABLE 31

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 6-1/8 x 6-1/8 x 3/4 IN., TESTING METHOD 3 AND 6 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi	Breaking Stress - psi Excluding Edge Breaks
1	.7435	8152	400.5	24102	2.96	49150	-	1	45400	45400
2	.7473	8077	371.8	22375	2.77	39850	I	1	36600	36600
3	.7418	8120	412.8	24842	3.06	39350	1.26"T O	.58	21200	21200
4	.7420	8360	377.5	22718	2.72	36700	I	1	34100	34100
5	.7375	8090	402.0	24192	2.99	45600	Or	.5	21400	
6	.7420	8083	399.5	24042	2.97	47900	I	1	44500	44500
7	.7383	8196	390.0	23470	2.86	45450	Ir	1	42600	42600
8	.7410	8211	400.0	24072	2.93	38350	I	1	35700	35700
9	.7420	8328	389.3	23428	2.81	45900	I	1	42600	42600
10	.7390	8154	419.0	25215	3.09	43250	I	1	40500	40500
11	.7383	8175	402.0	24192	2.96	37000	Or	.5	17300	
12	.7385	7877	380.0	22868	2.90	32950	1.35"T O	.55	17000	17000
13	.7423	8205	412.5	24824	3.03	41700	I	1	38700	38700
14	.7428	8277	360.5	21695	2.62	33350	Or	.5	15400	
15	.7410	8475	392.8	23639	2.79	37600	Or	.5	17500	
16	.7400	8403	406.0	24433	2.91	40400	Ir	1	37700	37700
17	.7433	7892	383.8	23097	2.93	38900	I	1	36000	36000
18	.7420	8563	393.5	23681	2.77	20700	Or	.5	9600	
19	.7403	8264	400.0	24072	2.91	39950	Or	.5	18600	
20	.7435	8190	392.3	23609	2.88	47450	I	1	43900	43900
21	.7430	8354	387.3	23308	2.79	42900	I	1	39700	39700
22	.7410	8247	389.3	23428	2.84	39350	I	1	36600	36600
23	.7435	7806	410.5	24704	3.16	35350	I	1	32700	32700
24	.7410	8183	387.0	23290	2.85	32950	I	1	30700	30700
25	.7405	8137	414.3	24933	3.06	48700	Ir	1	45400	45400
		Mean		Mean	Mean				Mean	Mean
		8190		23770	2.90				32060	36930
									SD	SD
									11190	7640
									High	High
									45400	45400
									Low	Low
									9600	17000
									Range	Range
									35800	28400

TABLE 32
INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667
SAMPLE SIZE 12-1/4 x 12-1/4 x 1/2 IN., TESTING METHOD 6 and 12 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5000	244	4580	I	1	9500
2	.5000	238	4520	Ir	1	9400
3	.5000	246	4400	Ir	1	9200
4	.4980	240	4240	I	1	8900
5	.4980	248	4780	I	1	10000
6	.4490	228	5980	I	1	12500
7	.4958	238	5560	I	1	11800
8	.4972	240	5720	I	1	12000
9	.4952	229	5500	Ir	1	11700
10	.4932	236	3820	I	1	8200
11	.4968	237	4720	I	1	9900
12	.4985	241	4940	I	1	10300
13	.5000	240	5500	I	1	11400
14	.5010	241	5260	I	1	10900
15	.5008	233	4760	I	1	9900
16	.5025	230	4740	I	1	9800
17	.4990	228	4920	I	1	10300
18	.5025	229	5500	Ir	1	11300
19	.4975	232	4880	I	1	10300
20	.4995	232	5600	I	1	11700
21	.4975	234	5660	I	1	11900
22	.4952	229	4780	I	1	10100
23	.4975	232	5240	I	1	11000
24	.4995	230	4960	I	1	10300
25	.4985	232	5220	0.3"T O	.96	10400
26	.4968	240	6000	I	1	12600
27	.4965	230	6220	I	1	13100
28	.4958	226	5660	I	1	12000
29	.4995	226	5300	I	1	11000
		Mean 235			Mean	10740
					SD	1200
					High	13100
					Low	8200
					Range	4900

TABLE 33
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 12-1/4 x 12-1/4 x 1/2 IN., TESTING METHOD 6 and 12 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.5015	4486	158.8	9557	2.13	10840	I	1	22400
2	.4982	4462	154.0	9268	2.08	10920	I	1	22900
3	.4922	4413	169.0	10170	2.30	12680	I	1	27200
4	.4960	4484	164.0	9870	2.20	11800	I	1	24900
5	.4968	4430	166.8	10035	2.27	11200	I	1	23600
6	.4985	4624	163.8	9854	2.13	12140	I	1	25400
7	.4950	4626	168.0	10110	2.19	11720	I	1	24900
8	.4988	4554	155.5	9358	2.05	10540	I	1	22000
9	.4948	4471	168.5	10140	2.27	12240	I	1	26000
10	.5022	4539	163.5	9839	2.17	10160	I	1	20900
11	.4975	4537	171.8	10336	2.28	10580	I	1	22200
12	.4980	4550	160.8	9674	2.13	10960	I	1	23000
13	.4968	4494	185.5	11163	2.48	11920	I	1	25100
14	.5022	4435	172.0	10351	2.33	11200	I	1	23100
15	.4982	4358	169.8	10216	2.34	11440	I	1	24000
16	.4952	4499	161.0	9689	2.15	12660	I	1	26800
17	.5032	4560	160.5	9659	2.12	9980	I	1	20500
18	.5018	4426	178.0	10712	2.42	11680	1.17"T O	.80	19300
19	.5022	4441	162.0	9749	2.20	10100	I	1	20800
20	.5015	4430	155.8	9376	2.12	9820	I	1	20300
21	.4985	4490	173.2	10426	2.32	10980	I	1	23000
22	.4952	4441	165.8	9975	2.25	12640	I	1	26800
23	.4980	4375	167.2	10065	2.30	11520	I	1	24200
24	.4978	4435	155.0	9328	2.10	12280	I	1	25800
25	.4955	4390	164.8	9918	2.26	11060	I	1	23400
26	.5010	4418	150.5	9057	2.05	10940	I	1	22700
		Mean 4480		Mean 9920	Mean 2.22				Mean 23510
									SD 2150
									High 27700
									Low 19300
									Range 7900

TABLE 34

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 12-1/4 x 12-1/4 x 1/2 IN., TESTING METHOD 6 and 12 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor		Breaking Stress psi
1	.4968	5031	193.5	11645	2.31	13000	I	1		27400
2	.5005	5272	201.2	12111	2.30	11580	I	1		24000
3	.4898	5069	209.0	12578	2.48	14060	I	1		30500
4	.4940	5293	215.0	12939	2.44	11420	0.2"T 23° O	.94		22800
5	.4925	5417	222.8	13408	2.48	11780	I	1		25300
6	.4975	5050	199.2	11991	2.37	11540	I	1		24200
7	.4940	5114	218.2	13134	2.57	11660	I	1		24800
8	.4992	5059	203.8	12262	2.42	11480	I	1		24000
9	.4915	5436	231.2	13917	2.56	13520	I	1		29100
10	.4980	5421	213.2	12833	2.37	15520	I	1		32500
11	.4965	5414	219.2	13191	2.44	16280	I	1		34300
12	.4900	5676	237.2	14278	2.52	13480	I	1		29200
13	.4930	5591	233.5	14052	2.51	13320	Ir	1		28500
14	.4935	5385	214.8	12924	2.40	12240	I	1		26100
15	.4980	5400	224.8	13525	2.50	12960	I	1		27200
16	.4935	5453	225.8	13586	2.49	13860	I	1		29600
17	.4950	5410	223.5	13450	2.49	14050	I	1		29800
18	.5025	5640	209.5	12608	2.24	11810	I	1		24300
19	.4992	5329	216.2	13014	2.44	12830	I	1		26800
20	.4965	5429	218.8	13164	2.42	13520	I	1		28500
21	.4992	5325	204.5	12307	2.31	12420	I	1		25900
22	.4960	5276	218.8	13167	2.50	13260	I	1		28000
23	.5015	5265	211.5	12728	2.42	11470	I	1		23700
24	.4995	5016	181.8	10938	2.18	14900	I	1		31100
25	.5005	5314	218.2	13134	2.47	12760	I	1		26500
26	.4938	5299	209.5	12608	2.38	13840	I	1		29500
27	.4945	5368	217.2	13074	2.44	13140	I	1		27900
		Mean		Mean	Mean				Mean	27460
		5320		12910	2.42				SD	2880
									High	34300
									Low	22800
									Range	11500

TABLE 35

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667

SAMPLE SIZE 12-1/4 x 12-1/4 x 1/2 IN., TESTING METHOD 6 and 12 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4942	7515	300.2	18069	2.40	16340	I	1	34800
2	.4960	7331	291.8	17558	2.40	15000	I	1	31700
3	.5010	7338	292.8	17618	2.40	13560	Ir	1	28100
4	.4960	7353	315.2	18972	2.58	15340	0.1"T 68° O	.90	29300
5	.5025	7642	340.2	20476	2.68	15840	I	1	32600
6	.4935	7395	315.8	19002	2.57	15360	I	1	32800
7	.5040	7389	320.0	19258	2.61	15940	I	1	32600
8	.4958	7474	293.0	17633	2.36	14500	I	1	30700
9	.4965	7549	325.0	19558	2.59	15220	Ir	1	32100
10	.4982	7591	328.5	19769	2.60	12900	Ir	1	27000
11	.4985	7487	271.8	16354	2.18	15310	I	1	32000
12	.4992	7578	337.4	20305	2.68	16680	I	1	34800
13	.4910	7353	289.5	17422	2.37	14100	I	1	30400
14	.4978	7304	296.5	17843	2.44	15240	I	1	32000
15	.5060	7280	283.5	17061	2.34	14520	I	1	29500
16	.4928	7323	289.8	17437	2.38	16140	I	1	34600
17	.4960	7346	316.5	19047	2.59	17060	0.1"T O	.97	35000
18	.5005	7410	313.5	18866	2.55	13740	I	1	28500
19	.4960	7587	320.2	19273	2.54	17340	I	1	36700
20	.4942	7636	359.2	21617	2.83	15560	I	1	33100
21	.4950	7500	311.5	18746	2.50	19600	I	1	41600
22	.4932	7468	330.2	19874	2.66	17720	I	1	37900
23	.4972	7566	335.2	20175	2.67	17120	Ir	1	36000
24	.4970	7425	330.0	19859	2.67	15420	I	1	32500
25	.5015	7148	307.2	18490	2.59	13980	I	1	28900
		Mean		Mean	Mean				Mean
		7440		18810	2.53				32610
									SD
									3350
									High
									41600
									Low
									27000
									Range
									14600

TABLE 36

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 12-1/4 x 12-1/4 x 3/4 IN., TESTING METHOD 6 and 12 IN. DIAMETER CONCENTRIC RINGS, TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.7452	328				15240	I	1	14300
2	.7445	302				12740	I	1	12000
3	.7435	312				15100	I	1	14200
4	.7500	314				14440	0.25"T O	.96	12900
5	.7518	349				10120	I	1	9300
6	.7508	320				9120	0.50"T O	.92	7700
7	.7482	296				12480	I	1	11600
8	.7495	296				14840	I	1	13700
9	.7440	309				12320	I	1	11600
10	.7532	301				10400	0.50"T O	.92	8800
11	.7478	306				10840	I	1	10100
12	.7515	290				8240	I	1	7600
13	.7522	221				9400	I	1	8600
14	.7545	274				8920	Or	.50	4100
15	.7512	245				10120	I	1	9300
16	.7510	325				9800	Or	.50	4500
17	.7450	322				12060	O	.50	9600
18	.7432	328				14180	I	1	13300
19	.7425	341				13600	OE	.50	6400
20	.7450	325				14500	I	1	13600
21	.7528	343				15500	0.55"T O	.91	12900
22	.7528	346				12640	Ir	1	11600
23	.7508	240				7960	1.25"T O	.79	5800
24	.7425	346				14180	I	1	13400
25	.7438	325				11260	I	1	10600
26	.7528	325				13460	I	1	12400
27	.7520	324				11980	Ir	1	11000
28	.7538	322				12120	I	1	11100
29	.7512	328				9420	I	1	8700
30	.7530	317				15580	I	1	14300
31	.7462	309				13520	I	1	12600
		Mean 311						Mean	10570
								SD	2890
								High	14300
								Low	4100
								Range	10200

TABLE 37

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 12-1/4 x 12-1/4 x 3/4 IN., TESTING METHOD 6 AND 12 IN. DIAMETER CONCENTRIC RINGS,
TESTING MACHINE - BALDWIN, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.7502	8060	386.0	23229	2.88	31300	I	1	28900
2	.7448	8083	356.5	21454	2.65	40200	Ir	1	37700
3	.7455	8077	372.8	22432	2.77	39500	I	1	37000
4	.7502	8247	414.0	24915	3.02	39200	I	1	36200
5	.7560	8509	369.0	22206	2.61	44000	I	1	40000
6	.7572	8188	400.0	24072	2.94	43900	I	1	39800
7	.7502	7591	347.2	20894	2.75	35350	I	1	32700
8	.7490	7715	354.6	21340	2.77	38100	I	1	35300
9	.7445	7689	344.4	20726	2.69	36200	I	1	34000
10	.7460	7655	351.8	21168	2.76	38600	I	1	36100
11	.7562	7685	365.4	21990	2.86	38350	0.23"60°T O	.90	34900
12	.7475	7551	362.2	21800	2.89	36450	I	1	33900
13	.7550	8160	353.5	21274	2.61	35400	I	1	32300
14	.7508	8220	379.2	22823	2.77	37300	I	1	34400
15	.7442	8188	418.5	25185	3.07	41400	I	1	38900
16	.7522	8275	407.8	24538	2.96	33000	I	1	30300
17	.7530	8367	400.5	24102	2.88	39950	I	1	36600
18	.7543	8290	399.2	24027	2.90	39600	I	1	36200
19	.7498	8528	414.5	24945	2.92	41300	I	1	38200
20	.7480	8324	383.0	23049	2.77	42000	I	1	39000
21	.7460	8330	399.0	24012	2.88	36300	I	1	33900
22	.7498	8303	436.8	26287	3.16	35150	I	1	32500
23	.7512	8494	434.2	26130	3.08	44400	I	1	40900
24	.7508	7772	435.2	26193	3.37	44150	I	1	40700
25	.7460	8137	420.5	25306	3.11	42550	I	1	39800
26	.7435	8092	392.5	23621	2.92	37700	I	1	35500
		Mean 8100		Mean 23370	Mean 2.88				Mean 35990
									SD 3190
									High 40900
									Low 28900
									Range 12000

TABLE 38

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 3 x 13 x 3/16 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN.

TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Breaking Load lb.	Fracture Origin		Fracture Origin Factor	Breaking Stress psi
1	.1930	2.990	146	110.6		IC	1	11900
2	.1925	2.970	154	100.0	1.50"	OC	.63	6800
3	.1918	2.985	153	64.2		IE	1	7000
4	.1915	2.995	146	56.8		IC	1	6200
5	.1915	2.980	141	104.8		IC	1	11500
6	.1910	2.970	142	108.6		IE	1	12000
7	.1925	2.985	146	69.6		IC	1	7600
8	.1932	2.990	153	94.6	0.14"	OC	.97	9800
9	.1935	2.985	159	122.4	0.28"	OC	.93	12200
10	.1940	2.980	157	88.8	0.13"	OC	.97	9200
11	.1948	2.985	146	121.8	0.17"	OE	.96	12400
12	.1950	2.990	153	120.4		IC	1	12700
13	.1955	2.980	143	116.6		IC	1	12300
14	.1952	2.985	144	125.2	0.26"	OC	.94	12400
15	.1950	2.995	153	138.4		IC	1	14600
16	.1908	2.990	153	100.0	0.75"	OC	.81	9000
17	.1915	2.990	149	117.8	0.78"	OE	.81	11100
18	.2005	2.985	157	138.4		IE	1	13800
19	.2006	2.980	143	96.6	0.62"	OC	.85	8200
20	.2003	2.985	153	99.2	1.92"	OC	.52	5200
21	.2001	2.985	141	104.0		IC	1	10400
22	.1994	2.980	147	90.0	0.13"	OC	.97	8800
23	.1983	2.985	143	112.8		IC	1	11500
24	.1924	2.990	142	121.2		IC	1	13100
25	.1918	2.985	141	121.6		IC	1	13300
26	.1916	2.975	143	126.4		IC	1	13900
27	.1910	2.980	136	90.4		IE	1	10000
28	.1961	2.990	142	64.8		IC	1	10800
29	.1963	2.985	139	118.6	0.08"	OC	.98	12200
30	.1964	2.980	143	149.6		IC	1	15600
31	.1966	2.990	143	130.2		IC	1	13500
			Mean 147					Mean 10940; Low 5200; SD 2610; Range 10400; High 15600

TABLE 39
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 3/16 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fraction Origin	Fraction Origin Factor	Breaking Stress psi
1	.1064	2.99	4243	144.6	8702	2.04	176.0	IE	1	18300
2	.1065	2.98	4111	175.2	10547	2.55	216.5	IE	1	22600
3	.1056	2.98	4087	146.2	8801	2.14	201.4	IE	1	21300
4	.1056	2.98	3964	139.0	8365	2.10	191.6	IE	1	20200
5	.1052	2.99	4090	164.2	9882	2.40	192.4	0.21" OE	.95	19200
6	.1910	2.98	3928	158.8	9554	2.42	223.4	IC	1	24600
7	.1000	2.99	4053	155.2	9343	2.29	177.4	IC	1	19700
8	.1061	2.98	4056	141.2	8500	2.08	200.0	IE	1	21000
9	.1060	2.98	4077	156.5	9418	2.30	171.2	IC	1	18000
10	.1014	2.98	4017	160.0	9629	2.38	234.5	IC	1	25800
11	.1060	2.99	4038	150.8	9072	2.24	186.0	IC	1	19500
12	.1061	2.98	3923	154.8	9316	2.36	227.0	IC	1	23800
13	.1057	2.98	4111	149.2	8979	2.17	209.0	IE	1	22000
14	.1058	2.98	4045	159.0	9569	2.35	202.0	IE	1	21200
15	.1071	2.97	4038	156.4	9412	2.32	204.0	IE	1	21200
16	.1054	2.99	3983	160.8	9674	2.42	215.5	IC	1	22700
17	.1053	2.99	3921	170.2	10246	2.60	193.2	IE	1	20300
18	.1046	2.98	3987	156.0	9388	2.34	195.8	IE	1	20800
19	.1041	2.98	4066	130.0	7823	1.91	201.0	IC	1	21500
20	.1038	2.99	4034	172.8	10396	2.57	223.0	IC	1	23900
21	.1033	2.99	4011	179.0	10772	2.67	226.5	IC	1	24300
22	.1041	2.99	3968	145.2	8741	2.19	223.0	IE	1	23800
23	.1050	2.98	3953	171.2	10306	2.59	183.2	IC	1	19400
24	.1031	2.99	4060	139.8	8410	2.06	253.5	0.70" OC	.83	22500
			Mean		Mean	Mean				Mean
			4030		9370	2.31				21570
										SD
										2080
										High
										25800
										Low
										18000
										Range
										7800

TABLE 40

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 3/16 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fraction Origin	Fraction Origin Factor	Breaking Stress psi
1	.1951	2.980	5340	171.0	10291	1.92	203.0	0.21" OC	.95	20400
2	.1951	2.985	5402	163.0	9809	1.81	228.0	IC	1	24100
3	.1951	2.980	5446	175.8	10777	1.93	260.5	IC	1	27600
4	.1962	2.980	5276	187.5	11284	2.13	258.5	IE	1	27000
5	.1959	2.980	5272	184.0	11073	2.09	208.5	IC	1	21900
6	.1960	2.980	5263	198.2	11931	2.26	247.0	0.32" OE	.92	23900
7	.1952	2.980	5276	202.8	12201	2.30	196.5	IE	1	20800
8	.1952	2.980	5510	180.0	10832	1.96	192.0	IE	1	20300
9	.1959	2.980	5432	201.0	12096	2.22	197.0	IC	1	20700
10	.1953	2.980	5487	203.5	12247	2.22	244.0	IC	1	25800
11	.1954	2.980	5210	165.0	9930	1.90	176.0	IC	1	18600
12	.1942	2.980	5152	215.2	12954	2.50	214.0	IE	1	22800
13	.1931	2.980	5410	210.2	12653	2.33	246.0	IE	1	26600
14	.1982	2.980	5340	222.5	13390	2.50	230.0	IC	1	23600
15	.1984	2.980	5427	190.2	11449	2.10	226.0	IC	1	23100
16	.1980	2.980	5214	206.5	12427	2.37	244.0	IE	1	25100
17	.1948	2.980	5289	177.2	10667	2.01	209.0	IE	1	22200
18	.1949	2.980	5236	195.8	11783	2.24	202.5	IE	1	21500
19	.1947	2.980	5236	212.0	12758	2.42	219.0	IC	1	23200
20	.1943	2.980	5289	202.5	12186	2.29	243.0	IC	1	25900
21	.1979	2.980	5397	202.8	12201	2.25	288.5	IC	1	29700
22	.1982	2.980	5210	179.5	10802	2.06	214.5	IC	1	22000
23	.1948	2.985	5393	185.4	11157	2.06	253.5	IC	1	26900
24	.1950	2.980	5310	.202.2	12171	2.28	222.0	IE	1	23500
25	.1961	2.980	5308	226.0	13601	2.55	253.5	IE	1	26600
			Mean 5320		Mean 11700	Mean 2.19				Mean 23750
										SD 2750
										High 29700
										Low 18600
										Range 11100

TABLE 41
INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 3/16 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fraction Origin	Fraction Origin Factor	Breaking Stress psi
1	.1980	2.980	7723	275.6	16586	2.14	254.0	0.07" OE	.98	25700
2	.1973	2.980	7687	284.0	17091	2.21	250.0	IE	1	25800
3	.1977	2.980	7904	289.2	17407	2.19	284.5	IE	1	29300
4	.1951	2.980	7555	275.2	16565	2.18	258.0	IE	1	27300
5	.1951	2.980	7662	288.2	17347	2.25	251.5	IE	1	26600
6	.1972	2.980	7604	322.0	19378	2.54	266.0	IE	1	27600
7	.1973	2.980	7840	300.0	18054	2.29	251.5	0.70" OE	.83	21500
8	.1976	2.980	7734	273.5	16459	2.12	270.5	IE	1	27900
9	.1974	2.980	7798	285.5	17181	2.19	244.0	IE	1	25200
10	.1974	2.980	7593	274.8	16534	2.17	276.0	IC	1	28500
11	.1978	2.980	7649	301.5	18144	2.36	264.0	IE	1	27200
12	.1975	2.980	7670	291.8	17558	2.28	296.0	0.34" OE	.92	28000
13	.1994	2.980	7630	297.2	17889	2.33	265.0	IE	1	26800
14	.2003	2.975	7662	293.0	17633	2.29	249.0	IE	1	25000
15	.2003	2.980	7715	251.2	15120	1.95	238.5	IC	1	24000
16	.2005	2.980	7866	250.2	15060	1.90	303.0	IE	1	30400
17	.1970	2.980	7544	288.8	17377	2.29	246.0	IE	1	25300
18	.1960	2.975	7804	284.0	17091	2.18	257.0	IE	1	26800
19	.1967	2.975	7877	286.2	17227	2.18	274.0	IC	1	28600
20	.1970	2.980	7317	298.2	17949	2.44	261.5	IE	1	26900
21	.1978	2.980	7670	268.4	16152	2.10	293.5	IE	1	30200
22	.1973	2.980	7898	302.5	18204	2.29	301.0	IE	1	31200
23	.1974	2.980	7728	278.5	16760	2.16	253.5	IE	1	26200
			Mean 7700		Mean 17160	Mean 2.22				Mean 27040
										SD 2190
										High 31200
										Low 21500
										Range 9700

TABLE 42

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 3 x 13 x 1/4 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN, TESTING MACHINE - INSTRON, LOADING RATE 4000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2438	2.99	170	138.4	IC	1	9300
2	.2435	2.99	183	154.2	IE	1	10400
3	.2438	3.00	179	157.1	IC	1	10600
4	.2438	3.00	181	123.1	IC	1	8300
5	.2425	2.98	200	152.3	IC	1	10400
6	.2393	3.00	166	148.4	0.20" OC	.95	9800
7	.2393	2.98	128	77.3	0.11" OC	.97	5300
8	.2380	3.00	100	128.9	IC	1	9100
9	.2395	3.00	134	82.5	0.62" OC	.84	4900
10	.2393	2.99	102	84.2	IE	1	5900
11	.2390	3.00	128	93.6	IE	1	6600
12	.2393	3.01	134	92.3	IE	1	6400
13	.2395	3.01	109	156.0	IE	1	10800
14	.2395	3.00	126	134.0	IC	1	9300
15	.2373	3.01	132	107.8	IC	1	7600
16	.2370	3.00	228	140.0	IE	1	10000
17	.2398	3.00	164	106.8	IC	1	7400
18	.2405	3.00	94	159.8	IC	1	11100
19	.2390	3.00	113	130.3	IE	1	9100
20	.2400	3.01	132	170.7	IE	1	11800
21	.2398	3.00	109	167.0	0.49" OC	.88	10200
22	.2395	3.01	117	147.0	0.54" OE	.86	8800
23	.2410	2.00		176.2	IC	1	12100
24	.2405	3.00		124.0	IE	1	8600
25	.2380	2.99		149.6	IC	1	10600
26	.2385	3.00		140.0	IE	1	9800
27	.2380	3.00		133.2	0.37" OE	.91	8500
28	.2385	3.00		154.2	IE	1	10800
			Mean 142				Mean 9050 SD 1920 High 12100 Low 4900 Range 7200

TABLE 43
INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 1/4 IN., TESTING METHOD BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 8000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi.	Average DSR Reading	Surface Compression psi.	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi.
1	.2395	3.00	4015	169.0	10170	2.53	289	IE	1	20200
2	.2390	3.01	4058	140.5	8816	2.17	265	IE	1	18500
3	.2393	3.01	3972	163.3	9824	2.47	250	IE	1	17400
4	.2383	3.00	3813	139.5	8395	2.20	346	0.18" OE	.96	23300
5	.2363	3.00	3887	133.8	8049	2.07	294	IE	1	21100
6	.2385	3.00	3887	174.0	10471	2.69	306	IE	1	21500
7	.2388	3.00	4047	178.8	10757	2.66	290	IE	1	20400
8	.2390	3.00	3823	171.5	10321	2.70	366	IC	1	25600
9	.2383	3.01	3994	164.8	9915	2.48	239	IE	1	16800
10	.2380	3.01	4079	174.5	10501	2.57	338	IE	1	23800
11	.2393	3.00	4068	144.8	8711	2.14	270	IE	1	18900
12	.2390	3.00	4100	162.8	9794	2.39	215	IE	1	15100
13	.2385	3.00	4749	155.3	9343	1.97	217	IC	1	15300
14	.2405	3.00	3930	165.0	9937	2.53	320	IE	1	22100
15	.2378	2.99	4047	162.8	9794	2.42	298	0.38" OE	.90	19100
16	.2395	3.00	4154	169.8	10216	2.46	259	IE	1	18100
17	.2368	3.00	3802	133.5	8034	2.11	297	0.76" OE	.81	16900
18	.2388	3.00	4004	160.0	9629	2.40	323	IE	1	22700
19	.2388	3.00	4207	153.0	9208	2.19	327	IC	1	22900
20	.2385	3.00	3983	136.3	8200	2.06	325	0.68" OE	.83	19000
21	.2403	3.00	3909	141.8	8531	2.18	345	IE	1	23900
22	.2373	3.00	3962	141.5	8515	2.15	290	IE	1	20600
23	.2393	3.00	4143	140.8	8470	2.04	331	IE	1	23100
24	.2390	3.00	4132	161.0	9689	2.34	281	IE	1	19700
25	.2360	3.00	3994	152.0	9147	2.29	281	IC	1	20200
			Mean 4030		Mean 9380	Mean 2.33				Mean 20230
										SD 2780
										High 25600
										Low 15100
										Range 10500

TABLE 44

INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 1/4 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 8000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2390	3.00	4899	.1940	11674	2.38	247	IE	1	17900
2	.2400	3.00	5346	.2103	12653	2.37	295	IE	1	20500
3	.2395	2.99	5229	.2293	13796	2.64	378	0.31" OE	.92	24300
4	.2373	3.00	5218	.2138	12863	2.46	301	0.08" OE	.98	21000
5	.2388	3.00	4920	.1760	10592	2.15	249	0.24" OE	.94	16400
6	.2380	3.00	5005	.1903	11449	2.29	289	0.88" OE	.78	15900
7	.2403	3.00	5293	.1850	11133	2.10	282	IE	1	19500
8	.2388	3.00	5112	.1865	11224	2.20	278	IE	1	19500
9	.2388	3.00	5378	.1835	11043	2.05	277	Ic	1	19400
10	.2410	2.99	5187	.2003	12051	2.32	384	IE	1	26500
11	.2410	3.00	5368	.1973	11871	2.21	295	IE	1	20300
12	.2383	3.00	5304	.1915	11524	2.17	277	IE	1	19500
13	.2368	3.00	5293	.2150	12939	2.44	323	IE	1	23000
14	.2385	3.00	5538	.2190	13179	2.38	259	IE	1	18200
15	.2408	3.00	5410	.1835	11043	2.04	338	IE	1	23300
16	.2385	3.00	5421	.2008	12081	2.23	296	IE	1	20800
17	.2388	3.01	5485	.1995	12006	2.19	330	IE	1	23100
18	.2380	3.00	5261	.1980	11916	2.26	315	IE	1	22200
19	.2410	3.00	5144	.1913	11512	2.24	272	IE	1	18700
20	.2380	3.00	5133	.1775	10682	2.08	327	IE	1	23100
21	.2408	3.01	5112	.1913	11512	2.25	313	IE	1	21600
22	.2408	2.99	5048	.2005	12066	2.39	286	IE	1	19800
23	.2403	2.99	5208	.1950	11735	2.25	277	0.74" OE	.82	15800
24	.2398	3.00	5272	.1870	11254	2.13	291	IE	1	20200
25	.2388	3.01	5176	.2115	12728	2.46	349	0.97" OE	.76	18500
			Mean 5230		Mean 11860	Mean 2.27				Mean 20360
										SD 2630
										High 26500
										Low 15800
										Range 10700

TABLE 45
INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 1/4 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 8000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.2395	3.01	7285	269.5	16218	2.23	320	IE	1	22200
2	.2403	3.00	7125	292.5	17603	2.47	348	IE	1	24100
3	.2385	3.00	7349	284.3	17109	2.33	387	IE	1	27200
4	.2365	3.00	7189	279.3	16808	2.34	372	Ic	1	26600
5	.2395	2.98	7242	277.8	16718	2.31	278	IE	1	19500
6	.2375	3.00	7221	287.0	17272	2.39	344	IE	1	24400
7	.2400	2.99	7380	258.3	15544	2.11	390	IE	1	27200
8	.2368	3.00	7370	263.5	15857	2.15	283	IE	1	20200
9	.2390	2.99	7029	254.5	15316	2.18	394	IE	1	27700
10	.2410	2.99	7199	257.3	15484	2.15	368	0.31" OE	.92	23500
11	.2413	3.00	7285	281.3	16929	2.32	380	1.18" OE	.70	18400
12	.2398	3.00	7306	283.3	17049	2.33	329	IE	1	22900
13	.2383	2.99	7412	290.8	17500	2.36	375	0.52" OE	.87	23100
14	.2395	2.99	7466	318.5	19167	2.57	300	IE	1	21000
15	.2373	3.00	7306	288.3	17350	2.37	395	0.54" OE	.86	24300
16	.2413	3.01	7455	300.8	18102	2.43	417	0.93" OE	.77	21900
17	.2418	2.98	7583	299.3	18012	2.37	339	IE	1	23400
18	.2368	3.00	7349	268.8	16176	2.20	274	IE	1	19600
19	.2365	2.99	7285	291.5	17542	2.41	391	IE	1	28100
20	.2385	3.00	7434	284.5	17121	2.30	312	IE	1	21900
21	.2385	3.00	7455	284.0	17091	2.29	395	Ic	1	27800
22	.2388	3.00	7455	285.8	17199	2.31	367	0.22" OE	.94	24300
23	.2400	2.99	7487	300.8	18102	2.42	318	IE	1	22200
24	.2385	3.00	7508	298.8	17982	2.39	352	IE	1	24800
25	.2393	3.00	7498	288.5	17362	2.32	377	IE	1	26300
			Mean 7350		Mean 17210	Mean 2.32				Mean 23700
										SD 2800
										High 28100
										Low 18400
										Range 9700

TABLE 46

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 3 x 13 x 1/2 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN, TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4958	3.00	228	700	IE	1	11400
2	.4935	3.00	256	803	Ic	1	13200
3	.4935	3.00	253	684	IE	1	11200
4	.4943	3.00	251	767	Ic	1	12600
5	.4950	2.99	249	746	Ic	1	12200
6	.4960	3.00	256	799	0.84" OE	.79	10300
7	.4915	3.00	247	675	Ic	1	11200
8	.4920	2.99	249	740	Ic	1	12300
9	.4925	2.99	249	800	Ic	1	13200
10	.4928	3.00	253	778	Ic	1	12800
11	.4910	3.00	258	323	IE	1	5400
12	.4893	2.97	268	780	Ic	1	13200
13	.4895	2.97	266	753	Ic	1	12700
14	.4900	2.96	268	681	IE	1	11500
15	.4900	3.02	245	737	IE	1	12200
16	.4918	2.98	281	710	Ic	1	11800
17	.4898	3.00	262	661	IE	1	11000
18	.4928	2.99	264	891	Ic	1	14700
19	.4933	2.97	-	990	Ic	1	16400
20	.4905	2.98	258	673	Ic	1	11300
21	.4905	2.98	258	552	0.08" OE	.98	9100
22	.4908	2.97	266	772	Ic	1	13000
23	.4900	3.02	-	918	IE	1	15200
24	.4918	2.97	264	880	Ic	1	14700
25	.4918	3.00	247	608	IE	1	10100
26	.4928	2.97	256	926	Ic	1	15400
27	.4935	2.99	-	816	IE	1	13400
28	.4930	2.97	-	960	Ic	1	16000
			Mean 256				Mean 12410
							SD 2260
							High 16400
							Low 5400
							Range 11000

TABLE 47

INDIVIDUAL TESTING RESULTS, 1/2 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 1/2 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.	Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4825	3.00	4196	158.3	9523	2.27	998	Ic	1	17100
2	.4905	2.97	4326	161.0	9689	2.24	1352	0.30" OE	.92	21000
3	.4880	2.98	4418	177.0	10652	2.41	1092	Ic	1	18500
4	.4895	2.97	4371	180.3	10847	2.48	1216	Ic	1	20500
5	.4895	2.98	4430	183.5	11043	2.49	1184	Ic	1	19900
6	.4900	2.98	4239	184.0	11073	2.61	1124	Ic	1	18900
7	.4733	2.98	4367	183.8	11058	2.53	1352	Ic	1	24300
8	.4895	2.98	4488	160.5	9659	2.15	1294	Ic	1	21700
9	.4825	3.02	4450	179.0	10772	2.42	1416	Ic	1	24200
10	.4740	2.99	4307	187.3	11269	2.62	1180	Ic	1	21100
11	.4885	2.99	4266	173.5	10742	2.52	1184	Ic	1	19900
12	.4805	2.99	4464	173.3	10426	2.34	1328	Ic	1	23100
13	.4788	3.02	4373	176.0	10592	2.42	1218	Ic	1	21200
14	.4800	3.03	4403	157.5	9478	2.15	1432	Ic	1	24700
15	.4795	3.00	4405	180.3	10847	2.46	1282	Ic	1	22300
16	.4920	2.98	4375	189.0	11374	2.60	1220	Ic	1	20300
17	.4798	3.02	4405	181.0	10893	2.47	992	Ic	1	17100
18	.4925	2.97	4450	174.8	10516	2.36	1480	Ic	1	24700
19	.4965	2.97	4358	160.0	9629	2.21	1316	Ic	1	21600
20	.4930	2.96	4381	179.8	10817	2.47	1538	1.0" OE	.75	19300
21	.4943	2.99	4384	180.5	10862	2.48	1578	Ic	1	22600
22	.4923	2.97	4213	173.5	10441	2.48	1256	Ic	1	20900
23	.4915	2.97	4303	172.8	10396	2.42	1646	Ic	1	27500
24	.4908	3.00	4356	187.3	11269	2.59	1228	Ic	1	20400
25	.4960	2.98	4371	173.3	10426	2.39	1468	Ic	1	24000
			Mean 4360		Mean 10570	Mean 2.42				Mean 21470
										SD 2510
										High 27500
										Low 17100
										Range 10400

TABLE 48
INDIVIDUAL TESTING RESULTS, 3/4 TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 12 x 1/2 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.		Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4803	3.02	4780	2.11	12698	2.66	1240		Ic	1	21400
2	.4945	2.96	5378	2.00	12036	2.24	1618		Ic	1	26800
3	.4800	3.00	5306	2.40	14443	2.72	1398		Ic	1	24300
4	.4803	2.99	5276	2.20	13255	2.51	1448		Ic	1	25200
5	.4800	3.02	5412	2.23	13435	2.48	1568		Ic	1	27100
6	.4798	3.06	5233	2.11	12713	2.43	1398		Ic	1	23900
7	.4808	3.03	5274	2.31	13917	2.64	1586		Ic	1	27200
8	.4938	2.97	5103	2.01	12081	2.37	1600	0.4"	OC	.90	23900
9	.4830	2.99	5267	2.02	12156	2.31	1384		Ic	1	23800
10	.4828	2.99	5182	2.02	12156	2.35	1366		Ic	1	23500
11	.4805	3.00	5208	2.41	14518	2.79	1384		Ic	1	24000
12	.4835	3.00	5184	1.85	11148	2.15	1666		Ic	1	28500
13	.4930	2.98	5760	2.33	13977	2.43	2050		Ic	1	34000
14	.4918	3.02	5412	2.38	14323	2.65	1476		Ic	1	24300
15	.4898	3.02	5593	2.25	13525	2.42	1254		Ic	1	20800
16	.4760	3.02	5406	2.18	13134	2.43	1608		Ic	1	28200
17	.4798	3.00	5299	2.16	12984	2.45	1044		Ic	1	18100
18	.4905	3.00	5293	2.29	13751	2.60	1402		Ic	1	23300
19	.4795	3.00	5306	2.01	12111	2.28	1432	0.15"	OC	.96	24000
20	.4793	3.03	5189	2.07	12427	2.39	1184		Ic	1	20400
21	.4800	3.02	5246	2.31	13871	2.64	1458		Ic	1	25100
22	.4803	3.04	5225	2.18	13119	2.51	1594		Ic	1	27300
23	.4888	2.97	5250	2.13	12803	2.44	1350		Ic	1	22800
24	.4878	3.00	5353	1.89	11389	2.13	1732	0.3"	OC	.92	26900
25	.4908	3.00	5363	2.32	13977	2.61	1174		Ic	1	19500
26	.4775	3.01	5223	2.35	14157	2.71	1332		Ic	1	23300
27	.4805	3.00	5244	2.16	12969	2.47	1512		Ic	1	26200
			Mean 5290		Mean 13080	Mean 2.47					Mean 24590
											SD 3230
											High 34000
											Low 18100
											Range 15900

TABLE 49
INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 1/2 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.		Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.4890	2.97	8582	389.5	23440	2.73	1950		IE	1	33000
2	.4915	3.00	8558	363.2	21857	2.55	1460		Ic	1	24200
3	.4922	2.98	8388	317.5	19107	2.28	1596		IE	1	26600
4	.4940	2.97	8627	359.0	21605	2.50	1696		IE	1	28100
5	.4915	2.98	8671	374.2	22519	2.60	1720		IE	1	28700
6	.4928	2.99	8484	384.8	23157	2.73	1694		Ic	1	28000
7	.4910	2.99	8492	324.0	19498	2.30	1760		Ic	1	29300
8	.4920	2.97	8825	335.0	20160	2.28	2000	0.09"	OE	.98	32700
9	.4940	2.97	9042	340.8	20507	2.27	1814		IS	1	30000
10	.4938	2.97	8903	351.2	21135	2.37	1778		Ic	1	29500
11	.4945	2.97	8720	337.5	20311	2.33	1716		Ic	1	28400
12	.4930	3.00	8637	349.5	21033	2.44	1950	0.18"	OC	.96	30700
13	.4942	2.96	8667	367.2	22098	2.55	1958		Ic	1	32600
14	.4895	3.01	8633	370.0	22267	2.58	2130		Ic	1	35500
15	.4888	2.97	8595	372.2	22399	2.61	2160	0.25"	OE	.94	34300
16	.4885	2.97	8603	388.2	23362	2.72	1962		Ic	1	33200
17	.4898	2.97	8616	364.5	21936	2.55	1894	0.21"	OC	.95	30200
18	.4880	2.97	8627	339.5	20431	2.37	1740	0.18"	OC	.96	28200
19	.4930	2.98	8637	345.8	20810	2.41	1924		Ic	1	31900
20	.4880	2.97	8437	337.0	20281	2.40	1610		IE	1	27300
21	.4925	2.97	8552	342.5	20612	2.41	2240		Ic	1	37300
22	.4905	2.98	8609	346.5	20852	2.42	2150		IE	1	36000
23	.4944	2.98	8750	381.8	22977	2.63	1772		IE	1	29200
24	.4888	3.00	8652	384.2	23121	2.67	2040	0.25"	OC	.94	32000
25	.4885	2.98	8641	336.5	20251	2.34	2055		IE	1	34700
			Mean 8640		Mean 21430	Mean 2.48					Mean 30860
											SD 3240
											High 37300
											Low 24200
											Range 13100

TABLE 50

INDIVIDUAL TESTING RESULTS, ANNEALED TYPE I MIL-G-25667

SAMPLE SIZE 3 x 13 x 3/4 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN, TESTING MACHINE - INSTRON, LOADING RATE 5000 PSI/MIN.

Sample No.	Average Thickness in.	Average Width in.	Center Tension psi	Breaking Load lb.		Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.7378	2.98	170	1060	1.56"	OE	.61	4800
2	.7420	2.95	165	801	0.42"	OE	.90	5300
3	.7365	2.96	173	860	0.08"	OE	.98	6300
4	.7365	2.95	173	618		IE	1	4600
5	.7423	2.95	166	968		IE	1	7100
6	.7400	2.93	170	1498		IE	1	11200
7	.7403	2.97	-	2744		IE	1	20200
8	.7395	2.97	173	1062	0.32"	OE	.92	7200
9	.7423	3.02	164	800		IE	1	5800
10	.7390	2.94	170	611		IE	1	4600
11	.7425	3.00	-	1258		IE	1	9100
12	.7370	3.00	173	640		IE	1	4700
13	.7425	2.94	164	1038	0.72"	OE	.82	6300
14	.7403	2.97	172	893		IE	1	6600
15	.7400	2.97	181	512		IE	1	3800
16	.7383	2.98	173	774	0.91"	OE	.73	4400
17	.7385	3.01	180	730		IE	1	5300
18	.7398	3.00	-	543		IE	1	4000
19	.7395	2.96	160	1141		IE	1	8500
20	.7390	2.92	163	771	0.53"	OE	.87	5000
21	.7418	2.95	177	1510	2.31"	OE	.43	4800
22	.7388	3.01	176	859	0.32"	OE	.92	5800
23	.7398	2.90	172	763	0.92"	OE	.77	4400
24	.7388	2.94	170	1380	1.02"	OE	.74	7700
25	.7400	2.95	170	1236		IE	1	9200
			Mean 171					Mean 6670
								SD 3410
								High 20200
								Low 3800
								Range 16400

TABLE 51

INDIVIDUAL TESTING RESULTS, FULL TEMPER TYPE I MIL-G-25667
SAMPLE SIZE 3 x 13 x 3/4 IN., TESTING METHOD - BEAM LOADING - 4 AND 12 IN. SPAN,
TESTING MACHINE - INSTRON, LOADING RATE 8000 PSI/MIN.

Sample No.	Average Thickness in.	Center Tension psi	Average DSR Reading	Surface Compression psi	Surface To Center Ratio	Breaking Load lb.		Fracture Origin	Fracture Origin Factor	Breaking Stress psi
1	.7415	9568	436.2	26254	2.74	5700		Ic	1	41900
2	.7400	9504	457.8	27547	2.90	5130	0.50"	OC	.88	32700
3	.7415	9559	441.8	26585	2.78	4710	0.18"	OC	.95	32700
4	.7410	9660	425.5	25607	2.65	4890		OE	.91	33300
5	.7415	9853	452.2	27216	2.76	5000		Ic	1	36600
6	.7422	9762	449.2	27036	2.77	5320		IE	1	38300
7	.7425	9551	458.8	27608	2.89	6100		Ic	1	44800
8	.7422	9677	401.8	24177	2.50	4960		IE	1	36800
9	.7412	9402	466.2	28059	2.98	4290		IE	1	31000
10	.7388	9617	464.5	27954	2.91	4320		IE	1	32600
11	.7438	9802	460.0	27683	2.82	4370		IE	1	32100
12	.7408	9551	462.2	27818	2.91	5260		IE	1	38100
13	.7425	9711	468.8	28209	2.90	4920		IE	1	36100
14	.74[illegible]	9687	432.8	26043	2.69	4960		Ic	1	35600
15	[illegible]	9602	489.0	29428	3.06	4910		IE	1	35700
16	.7402	9657	441.2	26554	2.75	5500		IE	1	41000
17	.7428	9574	422.5	25426	2.66	5220		IE	1	38600
18	.7398	9779	481.5	28977	2.93	5240		Ic	1	38900
19	.7415	9653	426.5	25667	2.66	5410		IE	1	38800
20	.7410	9677	442.2	26615	2.75	4840		IE	1	34900
21	.7410	9745	429.8	25862	2.65	5400		IE	1	40100
22	.7440	9562	452.0	27201	2.84	5400	0.38"	OC	.91	34900
23	.7445	9660	447.0	26900	2.78	4000	0.10"	OE	.98	28500
24	.7390	9508	459.0	27623	2.91	5840	0.25"	OC	.94	39800
25	.7390	9645	420.0	25276	2.62	5000		Ic	1	37000
26	.7398	9717	402.8	24237	2.49	5120		Ic	1	38100
		Mean		Mean	Mean					Mean
		9640		26830	2.78					36500
										SD
										3690
										High
										44800
										Low
										28500
										Range
										16300